SCIENCE ABSTRACTS

SECTION A

PHYSICS.

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LETTERS AND SHORT NOTES.

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A star (*) indicates that the Abstract deals with Apparatus and Instruments.

APRIL, 1940.

GENERAL PHYSICS.

ATOMIC AND MOLECULAR STRUCTURE.

921. The meson. R. Peierls. *Phys. Soc., Reports,* **6,** *pp.* 78–94, 1939.

922. Instability of the meson. M. Ageno, G. Bernardini, B. N. Cacciapuoti, B. Ferretti and G. Wick. *Ricerca Scientifica,* **10,** *pp.* 1073–1081, *Dec.*, 1939.—The instability of the meson is demonstrated qualitatively by a measurement (comparing absorption in 3 km. of air with that in 39 cm. of Pb) in which only rays of vertical incidence are involved. By measuring the intensity for 2 angles of incidence a value between $2{\cdot}4$ and $4{\cdot}3 \times 10^{-6}$ sec. (according to the assumptions about the energy loss of mesons in air) is obtained for τ. L. E. F.

923. Meson theory of nuclear forces. Part I. General theory. H. A. Bethe. *Phys. Rev.*, **57,** *pp.* 260–272, *Feb.* 15, 1940.—In this paper, the meson theory of nuclear forces is presented in a simplified way. As in Yukawa's first paper, the forces between two nuclear particles are derived directly from the field equations and the Hamiltonian of the meson field, without quantization of the field. The charge dependence of the forces is discussed and it is found that only two assumptions are in agreement with experimental facts, notably the equality of the forces between two like and two unlike nuclear particles in the singlet state. These assumptions are either (1) that nuclear particles interact only with neutral mesons (neutral theory) or (2) that they interact equally strongly with neutral positive and negative mesons (symmetrical theory). It is then shown that the part of the force which does not depend on the spin of the nuclear particle does not fulfil any useful function in the theory. Accordingly, the hypothesis is made that this part is absent so that there is only a spin-dependent interaction (single force hypothesis). Finally, it is pointed out that the interaction must be cut off at small distances in order to obtain finite eigenvalues for the deuteron. Such a cutting off is to be expected from the general theory, particularly because of the possibility of the simultaneous emission of two or more mesons. The cut-off is to be expected at a distance r_0 of about one-third the range of the nuclear forces. Author.

924. Statistical method in nuclear theory. K. Fuchs. *Roy. Soc., Proc. A,* **174,** *pp.* 509–522, *March* 8, 1940.—A generalization of the statistical method for the calculation of nuclear energies is given, which makes it possible to dispense with the Hartree approximation of independent wave functions. The two directions of the spin are considered separately and general expressions for the energy of nuclei with any spin are derived. Author.

925. Calculation of nuclear energies and stability by the statistical method. B. Spain. *Roy. Soc., Proc. A,* **174,** *pp.* 523–545, *March* 8, 1940. —Nuclear energies and radii are calculated using the statistical method,

taking into account the two possible spin directions ; the interaction potentials of the various nuclear forces are assumed to be proportional to $(k + a/r) \exp(-r/a)$. The results obtained are in good agreement with experiment. The stability of nuclei is also investigated, giving satisfactory agreement with experiment for odd nuclei, but for even nuclei the results are not so satisfactory. This seems to indicate that the statistical method does not emphasize sufficiently the difference between odd and even nuclei. AUTHOR.

926. Ortho-para conversion of D_2 and electric quadrupole moment of the deuteron. H. B. G. CASIMIR. *K. Onnes Lab., Leiden, Comm. Suppt. No.* 89. *Physica*, **7**, *pp.* 169–176, *March*, 1940. *In English.*—The influence of the interaction between inhomogeneous electric fields and the quadrupole moment of the deuteron on the ortho-para conversion of deuterium is discussed and it is shown that the experimental results of Farkas and Sandler [see Abstract 1398 (1939)] on the conversion of H_2 and D_2 in diamagnetic liquids can be explained by assuming the existence of a quadrupole moment of the order of magnitude found by Rabi and his collaborators. [See Abstract 4578 (1939).] AUTHOR.

927. Hypothesis of the existence of contraterrene matter. V. ROJANSKY. *Astrophys. J.*, **91**, *pp.* 257–260, *March*, 1940.—Symmetry arguments suggest the possibility of existence of atoms (here called " contraterrene ") consisting of negatively charged nuclei surrounded by positrons. In this note it is assumed that a fundamental contraterrene particle and the corresponding ordinary (here called " terrene ") particle annihilate each other on collision. Annihilation effects should make it possible to identify contraterrene matter (which presumably cannot be distinguished from terrene matter spectroscopically) provided that it can be observed in the process of colliding with terrene matter. Within the solar system perhaps the only bodies that are not certainly terrene are some meteors and comets. AUTHOR.

***928. Separation of isotopes.** H. C. UREY. *Phys. Soc., Reports*, **6**, *pp.* 48–77, 1939.

929. Quantitative and model data for the systematic study of isotopes. H. JENSEN. *Naturwiss.*, **51**, *pp.* 841–850, *Dec.* 22, 1939.—This comprehensive paper assembles data for the study of isotopes under the following headings : atomic weights of the lighter nuclei ; atomic weights of the heavier nuclei and the limits of stable nuclei ; bond energies and geochemical frequencies ; birth of elements ; nuclear moments ; and representations by models. The subject matter is illustrated by 5 sets of diagrams. H. H. Ho.

930. Nuclear properties of Sm and its structural isomerism. W. WEFELMEIER. *Ann. d. Physik*, **36**, 3–4, *pp.* 373–380, *Oct.*, 1939.—The Sm nucleus is noteworthy in that it exhibits α-activity, an anomalous distribution of isotopes with regard to their relative abundance and a discontinuity in the isotope displacement effect of its hyperfine structure. An attempt is made to explain these anomalies in terms of the unfavourable energetic position of the Sm nucleus on the mass-defect curve, the hypothesis of transitions between isobares after the setting up of interelemental equilibrium and the assumption of two different isomeric Sm nuclei. J. E. K.

931. Nuclear isomerism. R. G. SACHS. *Phys. Rev.*, **57**, *pp.* 194–197, *Feb.* 1, 1940.—It is suggested that nuclear isomerism may be due to the fact that the two lowest nuclear states have zero angular momentum and

opposite parity. The lifetime of the first excited state is estimated under these conditions for the emission of two quanta and for the ejection of two electrons from the K or L shell. The possibility of distinguishing experimentally between this hypothesis and that of Weizsäcker is discussed. AUTHOR.

932. Development of the concept of co-ordination. G. B. BONINO. *Gazz. Chim. Ital.*, **69**, *pp.* 763–779, *Dec.*, 1939.—The author discusses critically the two principal methods of approximation in quantum-mechanical study, *viz.*, Slater's and Pauling's localized bonding [see Abstracts 333 and 3034 (1932)] and Mulliken's orbital method [see Abstract 1670 (1933)]. He draws attention to the analogy between the latter concept and that of Werner, and attempts to generalize the whole idea of co-ordination. In this point of view, molecular symmetry assumes a discriminatory position and the idea of co-ordination may be extended to organic compounds. From the theory of groups the author investigates the constitution of the CH_4 molecule and the CO_3'' ion, using a general and unitary concept of the action of valency in chemical combination. The molecular symmetry deduced theoretically is in accordance with experimental results. D. R. H.

933. Directed valence. G. E. KIMBALL. *J. Chem. Phys.*, **8**, *pp.* 188–198, *Feb.*, 1940.—The problem of directed valence is treated from a group theory point of view. A method is developed by which the possibility of formation of covalent bonds in any spatial arrangement from a given electron configuration can be tested. The same method also determines the possibilities of double and triple bond formation. Previous results in the field of directed valence are extended to cover all possible configurations from 2 to 8 *s*, *p*, or *d* electrons, and the possibilities of double bond formation in each case. Examples are discussed. AUTHOR.

934. Theory of molecular structure. W. G. PENNEY. *Phys. Soc., Reports*, **6**, *pp.* 212–237, 1939.

935. Structure of fluorene. E. BERGMANN AND T. BERLIN. *Am. Chem. Soc., J.*, **62**, *pp.* 316–317, *Feb.*, 1940.—2-Acetoxyfluorene and 2-acetoxyfluorenone, on Fries rearrangement, give the 1-acetyl-2-hydroxy compounds. From 2-allyloxyfluorenone, both 1- and 3-allyl-2-hydroxyfluorenones are obtained in the form of a molecular compound. These facts support the conclusion drawn by Lothrop [see Abstract 3846 (1939)] that no fixed " fine structure " exists in fluorene ; the dibenzocyclopentadiene formula, however, seems to prevail. AUTHORS.

936. Determination of internuclear distances and of dissociation energies from force constants. G. B. B. M. SUTHERLAND. *J. Chem. Phys.*, **8**, *pp.* 161–164, *Feb.*, 1940.—With a view to obtaining the internuclear distances and dissociation energies of individual bonds in polyatomic molecules purely from a knowledge of force constants the consequences of assuming that the potential energy of any di-atom may be expressed in the form $V = -\alpha/r^m + \beta/r^n$ have been further investigated. In addition to giving a relation between internuclear distance and force constant of the form suggested empirically by Badger [see Abstract 4779 (1935)] this assumption leads to a relation between force constant (k_e), internuclear distance (r_e) and dissociation energy (D_e) of the form $D_e = (k_e r_e^2)/mn$. It is found that such a relation does exist between those quantities for series of diatomic molecules belonging to the same row in the periodic table, provided one uses an " effective " internuclear distance $r_e - d_{ij}$. This was also used by Badger in his relation of force constant to internuclear distance and the values of d_{ij} obtained by the two different methods are in

reasonably good agreement. The values obtained for the product mn are 4, 6·2, 6·2 and 10·8 for the respective series LiH to FH, Li_2 to F_2, Na_2 to Cl_2 and K_2 to Br_2. For the hydrides it would seem that $-\alpha/r+\beta/r^4$ is the correct form with β varying along the series. It is also shown that this function leads to a relation between the shift in frequency $\delta\nu$ and the change in bond energy δD in the formation of a hydrogen bond. AUTHOR.

937. Associating effect of the hydrogen atom. L. HUNTER AND J. A. MARRIOTT. *Chem. Soc., J., pp.* 166–170, *Feb.*, 1940.—Cryoscopic measurement has been made of the molecular weights of a number of nitro-substituted arylhydrazones over a range of concentration. The results provide direct evidence of a type of hydrogen-bond association long assumed on theoretical grounds to be operative in certain substances, *viz.*, that due to the union of unlike groups in separate molecules. Two different kinds of hydrogen-bond association are therefore distinguishable :

1. Homogeneous association—between typical associating groups of the same kind, as in phenols (—OH-----HO—), oximes (=NOH-----HON=) amides (—CO·NHR-----NHR·CO—), etc.

2. Heterogeneous association—between electron-donor and electron-acceptor groups of different kinds, e.g., $—NO_2$-----HO—, $—NO_2$-----HNAr·N=, and presumably many others. AUTHORS.

938. Interrelation of molecular constants for diatomic molecules. Part II. R. A. NEWING. *Phil. Mag.*, **29**, *pp.* 298–301, *March*, 1940.—In a previous paper [see Abstract 2129 (1935)] attention was drawn to the need for a theoretical basis for the nuclear distance r_e and the vibration frequency ω_e. Subsequent investigations have shown that it is very difficult to produce specific results on account of the generality of the problem, and that the best hope of progress would be to relate the empirical results to some general physical principle. It is now indicated that the empirical laws may be related to the existence, in the neighbourhood of the equilibrium configuration, of a common repulsive field for all similar molecules, provided that the laws are of the form $\mu\,\omega_e^2 f(r_e) = C$, C being a constant for similar molecules and μ the reduced mass. The advantage of using the equation $4\pi^2\mu\omega_e^2 = -1/r_e\,(d\mathrm{T}/dr)_{r=re}$ in any general investigation, where T is the mean value of the electronic energy and is a function of r, which has been deduced from Slater's results, is that it is only necessary to consider the repulsive term in the neighbourhood of equilibrium configurations. H. H. Ho.

See also Abstracts 928, 945, 964, 965, 983, 997, 1115, 1171, 1174, 1220.

COLLOIDS.

939. Chemical preparation of colloidal suspensions in non-aqueous solvents. A. A. VERNON AND H. A. NELSON. *J. Phys. Chem.*, **44**, *pp.* 12–25, *Jan.*, 1940.—Using hydrazine hydrate, P, tannin, $SnCl_2$, and other reducers, stable colloidal suspensions in CH_3OH or C_6H_6 of Au, Ag, Pb, Bi, Sb, Ni, Cr, Co, Cu, Hg, and Sn were prepared from salts of 0·001 to 2·0% concentration. Metallic sulphide sols were prepared in the same media by passing dry H_2S through dilute solutions of the salts. Protective colloids were generally found necessary for stability : cellulose nitrate of $\sim$ 0·2% for sols in alcohol, and rubber for sols in C_6H_6. Some unprotected sulphide sols were very stable, but unprotected metal sols were short-lived. Colours of the sols by reflected and transmitted light, and general behaviour and effect of ageing are described. Sols in ether, dioxane, and acetone, of the same metals and of Fe, were prepared by reduction methods,

and sols of metallic sulphides in the same solvents by double decomposition with H_2S. Protectors necessary to ensure stability were cellulose nitrate with dioxane and acetone, and rubber with ether. It was found that the suspensions decrease in stability in the order alcohol, dioxane, C_6H_6, ether, acetone. N. M. B.

940. Kinetic theory of elasticity of rubber. H. Pelzer. *Phys. Soc., Reports*, **6**, *pp.* 330–334, 1939.

***941. Moisture meter for textile materials.** E. H. Jones. *Journ. Sci. Instruments*, **17**, *pp.* 55–62, *March*, 1940.—An instrument is described which estimates the moisture content of certain textile materials by utilizing the relationship which exists between their moisture condition and electrical resistivity. A novel electrode system is used which practically eliminates any variations in resistance which might otherwise arise from variations in the shape, size, or initial density of packing of the material and, by employing a stainless steel anode, renders negligible any errors due to polarization effects. By employing interchangeable electrode systems having different conductance factors, the range of resistance covered by the meter may be made to apply to materials of widely different resistivities. The instrument employs common types of thermionic valves incorporated in a circuit so designed that simple adjustments can be made to correct for differences in the emission of valves and variations in mains voltage without affecting the original calibration. Author.

942. Water-in-oil emulsions. Part III. R. C. Pink. *Chem. Soc., J., pp.* 211–212, *Feb.*, 1940.—The effect of the relative phase volumes on the type of emulsions stabilized by magnesium oleate has been investigated. The type of emulsion produced depends to a certain extent on its method of preparation, but with a suitable method and with a sufficient concentration of soap, emulsions containing 90% of water dispersed in benzene can readily be obtained. A number of the water-continuous emulsions underwent a reversal of type on standing. [For Part II see Abstract 2282 (1939).] Author.

943. Hydrous $La(OH)_3$ as an emulsifying agent. T. Moeller. *J. Phys. Chem.*, **44**, *pp.* 259–263, *Feb.*, 1940.—Hydrous $La(OH)_3$, whether colloidally dispersed, flocculated from a sol by certain electrolytes, or precipitated from La salt solutions, stabilizes oil-in-water emulsions. The dispersed phase may be benzene, toluene, xylene, mesitylene, kerosene, gasolene, or turpentine. Emulsions are not produced with ether, isoamyl alcohol, CCl_4 or $CHCl_3$. Author.

944. Electrophoretic technique. Part I. Electrophoresis of hemocyanins. A. Tiselius and F. L. Horsfall, Jr. *Arkiv f. Kem. Min. och Geologi*, *A*, **13**, 18, *pp.* 1–20, 1939. *In English.*—Using the hemocyanins of Helix pomatia and Helix nemoralis as test objects a quantitative study has been made of certain characteristics of the electrophoretic technique. Multiple scale-method electrophoretic diagrams have been used throughout these investigations. Evidence concerning the reproducibility of mobility determinations, alterations in mobility which follow upon dissociation and subsequent reassociation, accuracy of component concentration calculation from scale-method diagrams, asymmetry of boundaries and the reversible boundary spreading phenomenon has been presented. From a consideration of the reversible boundary spreading phenomenon it seems probable that the two hemocyanins studied exist simultaneously in a number of forms all of which have the same molecular weight but differ slightly from one another electrochemically. Authors.

945. New views on starches. K. FREUDENBERG, E. SCHAAF, G. DUMPERT AND T. PLOETZ. *Naturwiss.*, **51**, *pp.* 850–853, *Dec.* 22, 1939.—Starches are resolved by *bacillus macerans* to a mixture of crystallized dextrines which consist mainly of two components named α- and β-dextrines. The α-dextrine is a cyclic polysaccharide which consists of 5 glucose units connected by 5 maltose bonds, while the β-dextrine contains 6 glucose units similarly connected. It has been found that these systems are present in the starches prior to resolution. The molecular model of α-dextrine is discussed at length with several illustrative diagrams and in connection with spiral models for starches. H. H. Ho.

***946. Application of Toepler's schlieren method to analytical ultracentrifuge.** J. A. CHILES, JR., AND A. E. SEVERINGHAUS. *Rev. Sci. Instruments*, **11**, *pp.* 71–76, *Feb.*, 1940.—An application of Toepler's schlieren method to the analytical air-driven vacuum ultracentrifuge is described. The optical system uses lenses of 32 mm. aperture and 60 mm. focal length, and has a sensitivity great enough to utilize the full possibilities of the instrument as limited by compressibility effects in the analytical cell. A mechanism is described whereby the knife-edge position and the direction of the beam of light to the camera may be adjusted from the camera end of the system. The camera and knife-edge mechanism are mounted on a sliding carriage, permitting them to be drawn out of the way when the centrifuge is to be removed from the vacuum chamber. AUTHORS.

See also Abstracts 965, 1004, 1143, 1204, 1238.

CRYSTAL STRUCTURE AND SPECIAL PROPERTIES.

947. Phase changes in crystals arising from hindered molecular rotation. J. G. KIRKWOOD. *J. Chem. Phys.*, **8**, *pp.* 205–212, *Feb.*, 1940.—A theory of phase changes due to hindered molecular rotation in crystals is developed on the basis of classical statistical mechanics. It is demonstrated that local hindrance of relative rotation of neighbouring molecules in the lattice can produce a non-uniform distribution in orientation below a certain critical temperature. The theory provides a semi-quantitative description of the behaviour of the hydrogen halides in certain of their lambda-transitions, with a relative torque potential of the form $(\epsilon/2)\cos\gamma$ for a pair of neighbouring molecules, the axes of which are inclined at an angle γ to each other. The barrier height ϵ is estimated to be between 200 and 300 cal./mole for HI and HBr. AUTHOR.

948. Acceleration of electrons in a crystal lattice. W. V. HOUSTON. *Phys. Rev.*, **57**, *pp.* 184–186, *Feb.* 1, 1940.—The motion of an electron in a periodic potential field, and accelerated by a uniform field, can be obtained by treating the time-dependent Schrödinger equation. The result shows that the wave vector increases linearly with the time within the bounds of a single Brillouin zone. At the boundaries of the zones transitions to other zones may take place if the accelerating field is large enough. AUTHOR.

949. X-ray emission spectra and electronic structure of Al-Cu and Al-Ni alloys. J. FARINEAU. *J. de Physique et le Radium*, **10**, *pp.* 327–332, *July*, 1939.—The author deduces electronic structures from variations in intensity of Al $K\beta_x$, Cu $L\alpha$, Ni $L\alpha$ bands derived from outer electrons. Data are reported from 7 Cu-Al and 5 Ni-Al alloys as well as the constituent metals. For Al $K\beta_x$ radiation the variation is small and continuous, confirming Jones' theory that the conductivity electrons are shared in common within the Brillouin zones; where crystal data allow these to be computed the agreement is good. With rising Al content the Cu $L\alpha$

band also widens but not to the same extent, in Al-rich alloys it resembles that of pure Cu. It appears therefore that conductivity electrons are distributed as a function of energy nearer that of free electrons, those of low energy do not penetrate the Cu atom but prefer to remain near the Al ion. In Al-Ni alloys the Ni$L\alpha$ band at 845-854 eV decreases in intensity and broadens with increasing Al content. Conductivity electrons appear to be deposited outside Al ions, and penetration of the Ni atom is small. This is quite different from the results obtained for Al-Mg alloys [see Abstract 910 (1939)]. D. R. H.

950. Crystal chemistry of AB_2 intermetallic compounds. G. E. R. Schulze. *Zeits. f. Elektrochem.*, **45**, *pp.* 849–865, *Dec.*, 1939.—A critical theoretical review under the heads.—1. Validity of the law of multiple proportions. 2. Crystal Structures. Mutual relations of 3 such lattices. 3. Exact limits. 4. Geometrical properties. Distance and co-ordination ratios, radius quotients and the lattice. 5. Comparison of these compounds and elements. 6. Energy considerations. 7. Electronic properties of the B atoms. 8. *d*-electron shells in the noble metals, non-transition metals. 9. Exchange effect. 10. Can the same binding mechanism occur in other lattices? 11. Applications to ternary systems —Mg-Zn-Cu. 12. Summary. The author concludes that the high effective co-ordination number 16 for the A atoms shows the *metallic* nature of the binding face they exert, B atoms showing only 6. Shortening of the atomic radius (compared with that of the pure element) occurs, and the B lattice is more important than that of A. Since B-B binding is permitted by the low co-ordination number (participation of the next outer electron shell) the binding energy for the B lattice is greater than in the element; to form such compounds the next outer shell of B must be incomplete, with radius about 20% less than A, which must be a strongly metallic element. In view of the governing factors of structural type, spatial relations and size ratios, the same mechanism of binding is unlikely to occur in other compounds. D. R. H.

951. X-ray investigation of Cu-Sb alloys. A. Ôsawa and N. Shibata. *Tohoku Univ., Sci. Reports*, **28**, *pp.* 1–20, *Oct.*, 1939. *Report No.* 458 *of the Research Inst. for Iron, Steel and other Metals.*—Careful X-ray analyses by various methods have been carried out for all the phases existing in this alloy system, α, $\beta(Cu_5Sb_2)$, $\gamma(Cu_2Sb)$, $\delta(Cu_9Sb_2)$, $\eta(Cu_{11}Sb_2)$, $\theta(Cu_{11}Sb_4)$ and ϵ, and the crystal class, lattice constants, number of atoms in unit cell, etc., have been determined. Specific gravity measurements of the alloys are also made. Authors.

952. Structural changes due to quenching and tempering of β-phase alloys of the Cu-Sb system. A. Ôsawa and N. Shibata. *Tohoku Univ., Sci. Reports*, **28**, *pp.* 197–216, *Oct.*, 1939. *Report No.* 462 *of the Research Inst. for Iron, Steel and other Metals.*—Alloys of β-phase of the Cu-Sb system were quenched and tempered, and an intermediate phase β' thereby formed was closely examined by means of microscopic, differential dilatometric and X-ray methods. It was shown that the β' phase in the dilatation demonstrates a characteristic tempering curve, which may also be seen in the tempering of cast specimens, and also that the crystal lattice of β' phase interchanges the axis of a and c at about the eutectoid composition (63·5% Cu), which fact seems to present a new datum for the properties of the intermediate phase. Authors.

953. Lattice spacings of primary solid solutions of Ag, Cd and In in Mg. G. V. Raynor. *Roy. Soc., Proc. A*, **174**, *pp.* 457–471, *March* 8, 1940.—Accurate measurements have been made of the lattice spacings of the

primary solid solutions of Ag, Cd and In in Mg. At equiatomic compositions, decreasing the valency of the solute increases the lattice distortion in the basal plane. In dilute solution, In, Cd, and Ag contract the "*a*" parameter by amounts proportional to 1 : 2 : 5 respectively, while the volume of the unit cell is contracted by amounts proportional to 1 : 3 : 9 respectively. The "*a*"-parameter factors may be expressed as $1 + (3 - \text{valency})^2$ and the volume factors as $1 + 2(3 - \text{valency})^2$. There is no such regularity for the "*c*" parameters. The results may be interpreted qualitatively in terms of the Brillouin zone theory of metals. AUTHOR.

954. Equilibrium and lattice-spacing relations in the system Mg-Cd. W. HUME-ROTHERY AND G. V. RAYNOR. *Roy. Soc., Proc. A*, **174**, *pp.* 471–486, *March* 8, 1940.—The equilibrium diagram of the system Mg-Cd has been investigated by thermal, microscopic and X-ray methods. The liquidus and solidus curves pass smoothly from the melting point of Mg to that of Cd, with no indication of a discontinuity characteristic of a peritectic reaction. Microscopic methods show no indication of a 2-phase region above the temperatures of the superlattice transformations. The supposed compound $MgCd_2$ of Hume-Rothery and Rowell is not a true constituent of the system Mg-Cd but is an oxide-nitride complex formed when the alloys are exposed to the atmosphere. It is formed most readily when the composition of the alloy corresponds with the formula $MgCd_2$; a somewhat similar effect has been noted in the system Ni-Cr. The 2-phase region claimed by Grube and Schiedt is not confirmed. The lattice spacings of a complete series of alloys at 310°C. have been measured with a high-temperature X-ray camera. The first additions of Cd to Mg cause a contraction of the *a* parameter of the unit cell, but have little effect on the axial ratio, so that the *c* parameter contracts in almost the same proportion. With further additions of Cd the axial ratio increases slightly. The addition of Mg to Cd causes an expansion of the *a* parameter, but, at the same time, the axial ratio decreases so markedly that the *c* parameter diminishes, so that each metal decreases the *c* parameter of the other. A stage is then reached at which the solid solutions derived from Mg and Cd acquire identical lattice spacings which persist unchanged over a narrow range of compositions. These effects are discussed, and are shown to be in agreement with the Brillouin zone theory developed by Jones. AUTHORS.

955. Order-disorder transformation in alloy Ni_3Mn. N. THOMPSON. *Phys. Soc., Proc.*, **52**, *pp.* 217–228, *March*, 1940.—Measurements have been made of the magnetization, electrical resistance and specific heat of the alloy Ni_3Mn during the progress and after the completion of a variety of heat treatments. The evidence indicates that at 510°C. an order-disorder transformation occurs, and that the ordered structure is ferromagnetic with a Curie point at 460°C. The sharp decrease of resistance on slow cooling takes place at the Curie point. The effect of the degree of order and of the size of the ordered regions on the resistance and the magnetization is discussed in the light of the experimental results. AUTHOR.

956. X-ray study of natural and artificial mullites. H. P. ROOKSBY AND J. H. PARTRIDGE. *Soc. Glass Technol., J.*, **23**, *pp.* 338–346, *Dec.*, 1939.—X-ray studies indicate that there are three varieties of mullite distinguishable by the differences in axial ratios of the unit cell. They are: α-mullite made from pure materials corresponding to the formula $3Al_2O_3$, $2SiO_2$ and containing 28·2% SiO_2, 71·8 Al_2O_3; β-mullite containing excess alumina in solution; and γ-mullite containing small proportions of ferric oxide and/or titania in solution. All 3 varieties have been pre-

pared artificially, but so far only the β- and γ-varieties have been found as minerals. β-mullite can contain as high as 78% of alumina, although there is a progressive change in the lattice from the α- to the β-variety as the alumina content rises above 72%. γ-mullite is obtained when comparatively small proportions of iron or titanium oxides are present; with larger proportions a general expansion of the lattice occurs. β-mullite containing 78% of alumina corresponds to the formula $2Al_2O_3$, SiO_2. It is clear that the replacement of Si by Al is not limited to the change from sillimanite to α-mullite, but can be carried a stage further until the composition of β-mullite is reached. AUTHORS.

957. Structure of LiOH,H_2O. R. PEPINSKY. *Zeits. f. Krist.*, **102**, 2, *pp.* 119–131, 1939. *In English.*—$LiOH \cdot H_2O$ is monoclinic prismatic, with axes $a = 7{\cdot}37$, $b = 8{\cdot}26$, $c = 3{\cdot}19$ Å, $\beta = 110° 18'$, and the axial ratios $a : b : c = 0{\cdot}892 : 1 : 0{\cdot}386$. The density is 1·51 gm./cc., and there are four molecules per cell. The space group is C_{2h}^3–C 2/m, which has reflection planes at y = 0° and y = 180°, and two sets of two-fold axes perpendicular to these planes. Each Li is at the centre of a tetrahedron of oxygens. Two such tetrahedra share an edge in a reflection plane and at an angle of 12·5° with the a-axis. Upper and lower corners of all tetrahedra are shared with tetrahedra in the cells immediately above and below, the edges between these shared corners being parallel to the c-axis. Thus paired tetrahedra form unending chains in the c-direction. Oxygens of the shared tetrahedron edges in reflection planes are in hydroxyl groups, and oxygens of upper and lower tetrahedron corners are in water groups. The chains of paired tetrahedra are linked sideways by hydroxyl bonding between the hydroxyls and waters. Separations between atoms within a tetrahedron and for nearest atoms in adjacent tetrahedra are tabulated. Relations between this structure and those given elsewhere for Li_2O and LiOH are discussed. AUTHOR.

958. Solid solutions in the ternary system ZnS-CdS-MnS. F. A. KRÖGER. *Zeits. f. Krist.*, **102**, 2, *pp.* 132–135, 1939. *In English.*—The ternary phase diagram for ZnS-CdS-MnS is given; the author concludes that precipitation depends much more on the difference between the kind of bonding between MnS and ZnS-CdS, than on discrepancies in lattice dimensions. D. R. H.

959. Structure of bromanil, $C_6Br_4O_2$. S. L. CHORGHADE. *Zeits. f. Krist.*, **102**, 2, *pp.* 112–118, 1939. *In English.*—Bromanil which is isomorphous with chloranil, crystallizes in the prismatic class of monoclinic crystals. Its unit cell has the dimensions $a = 8{\cdot}62$, $b = 6{\cdot}22$, $c = 17{\cdot}94$ Å; $\beta = 102°$, and contains 4 molecules of $C_6Br_4O_2$. An interesting feature of the structure is the pseudo-orthorhombic symmetry of the crystal, with the (201) plane—which is nearly perpendicular to the a-axis—as a plane of approximate symmetry. The observed extinctions are (hkl) with $(h + 1)$ odd, $(h0l)$ with h or l odd, and $(0k0)$ with k odd, which suggest that the space group is $C_{2h}^5 - B2_1/c$. The centering on the (010) face of the above unit cell may, however, be only apparent. The reflections from (hkl) planes corresponding to odd values of $(h + 1)$ are very weak in chloranil, and their absence in bromanil may be merely due to the larger absorption of the X-rays by this crystal. If this is so, then the space group of the above cell will be $C_{2h}^5 - P2_1/a$ as in chloranil, instead of $B2_1/c$. AUTHOR.

960. Structure of acid compounds of graphite. W. RÜDORFF. *Zeits. f. phys. Chem. Abt. B*, **45**, 1, *pp.* 42–68, 1939.—The parameters of the

C- and acid-layers in the c-direction have been obtained for 1 to 5 stages from intensity computations of the (0 0 l) interference of compounds of graphite with H_2SO_4, H_2SeO_4, and HNO_3. The dimensions of the c-parameters in the a- and b-directions for the same stages have also been determined for HNO_3- and $HClO_4$-compounds. The superstructure interference of the H_2SO_4-compound indicates for the first stage a triangular packing for the acid molecules or anions, and the relative positions of the acid layers in the a- and b-directions have been determined. W. R. A.

961. Unit cell and space-group of β-octamethylcellobiose and β-hendecamethylcellotriose. T. Ohasi. *Chem. Soc. Japan, Bull.*, **14**, *pp.* 517–520, *Dec.*, 1939.—By means of X-rays the dimensions of the unit cell have been determined to be $a = 12{\cdot}0$ Å, $n = 43{\cdot}7$ Å, $c = 4{\cdot}50$ Å for β-octamethylcellobiose and $a = 21{\cdot}3$ Å, $b = 34{\cdot}5$ Å, $c = 4{\cdot}50$ Å for β-hendecamethylcellotroise. These substances possess the same corresponding space group D_2^4–$P2_12_12_1$, the number of molecules in the unit being four. The results are completely different from those reported by Trogus and Hess [*Ber.*, 68 (1935), 1605]. Author.

962. X-ray studies on chloro-mercury alkyl mercaptides. A. Johansson. *Arkiv f. Kem. Min. och Geologi, A*, **13**, 14, *pp.* 1–11, 1939. *In English.*—The compounds CH_3SHgCl and C_2H_5SHgCl are monoclinic with the cell dimensions $a = 7{\cdot}45$ Å; $b = 7{\cdot}37$ Å; $c = 7{\cdot}82$ Å; $\beta = 86{\cdot}4°$ and $a = 9{\cdot}34$ Å; $b = 7{\cdot}45$ Å; $c = 7{\cdot}81$ Å; $\beta = 82{\cdot}5°$ respectively. The space group is C_{2h}^5–$P2_1/c$. There are 4 molecules in the cells and each atomic species is situated in a general position. The parameters have been determined and the ensuing structure has been found to have some features in common with that of the mercury alkyl mercaptides recently examined by Wells. [See Abstract 2913 (1937).] Author.

963. X-ray study of acetysalicylic acid incorporated in certain sugars. R. L. McFarlan and J. W. Reddie. *J. of Applied Physics*, **11**, *pp.* 80–82, *Jan.*, 1940.—An X-ray examination has been made of pure acetylsalicylic acid (aspirin) and of mixtures of aspirin and sugar containing from 0 to 5% aspirin. A definite change, from a crystalline to an amorphous state for at least some of the aspirin incorporated in the sugar base at 121°C, has been demonstrated. The conclusion is drawn that the amorphous aspirin is in solid solution in the sugar mass. [See Abstract 3757 (1938).] J. I.

964. Molecular structure factors and structures of complex organic crystals. G. Knott. *Phys. Soc., Proc.*, **52**, *pp.* 229–238, *March*, 1940.—The transforms of some simple molecules are derived and their application to the solution of crystal structures is indicated by an example (naphthalene). The transform of a complex molecule can be built up from the transforms of its component parts, and it is suggested that the method provides another approach to the problem of the solution of the structure of complex organic crystals. Author.

965. Size of tobacco mosaic particle from X-ray determinations. J. W. Gowen. *Nat. Acad. Sci., Proc.*, **26**, *pp.* 8–10, *Jan.*, 1940.—Preparations of 3 types of tobacco mosaic viruses are exposed to monochromatic X-rays from Cr, Cu and Ag anodes and the respective curves drawn giving the relation between number of particles surviving and dose of X-rays in roentgens. From these curves it is concluded that the molecular weight of the reproductive part of the virus particle is approximately 15×10^6. J. I.

966. Experiments on molecular structure of liquids by means of mechanical models. W. Kast and H. A. Stuart. *Phys. Zeits.* **40,** *pp.* 714–718, *Dec.* 15, 1939.—The models were 2-dimensional consisting of brass discs between two horizontal glass plates, the whole subjected to a rocking vertical motion of 40–100 periods per sec. Shape and density per unit area of the discs was varied. In some experiments one or more magnetized little steel rods were attached to the discs, thus representing molecular dipoles, quadrupoles, etc. Change in packing, association in chains or groups and obstruction of free rotation were observed as the consequences of molecular fields and of deviations from the circular shape of the molecules especially at high densities, when the groups tend to become larger and more static, corresponding to a transition to anisotropic liquids. L. E. F.

967. Concepts of form, characteristic and habit. W. Nowacki. *Zeits. f. Krist.*, **102,** 2, *pp.* 144–145, 1939.—The author proposes definitions :— 1. Form (*Gestalt*) = space complex of the bounding surfaces. 2. Characteristic (*Tracht*) = combination of the bounding crystal forms. 3. Habit = metrical development of forms, not definable mathematically. D. R. H.

968. Dehydration of crystals of chrome alum. J. A. Cooper and W. E. Garner. *Roy. Soc., Proc. A,* **174,** *pp.* 487–503, *March* 8, 1940.—Measurements have been made of the rate of growth of dehydration nuclei over the 111 surfaces of crystals of chrome alum for a range of temperatures. These rates have been compared with the rates of penetration into the crystal. The self-cooling of the crystals has been measured and the heat of dissociation calculated both from the self-cooling and the temperature coefficient of the dissociation pressure. The heat of dissociation, 10 kg.cal., is much less than the calculated activation energy for the dehydration, viz. 31 kg.cal. An explanation is advanced for the abnormally high activation energy. It is shown that small pressures of water vapour cause an acceleration of the rate of dehydration. Authors.

969. Isomorphous relationships of organic compounds of analogous constitution. N. M. Cullinane and W. T. Rees. *Faraday Soc., Trans.,* **36,** *pp.* 507–514, *March,* 1940.—The compounds examined include phenoxazine (I), phenthiazine (thiodiphenylamine) (II), diphenylene dioxide (III), phenoxthionine (IV), and thianthren (V). The results indicate that analogously constituted derivatives of elements of similar type form solid solutions, if their spatial structures are alike. Authors.

970. X-rays and crystals. *Phys. Soc., Reports,* **6,** *pp.* 345–377, 1939. —A progress review, edited by J. M. Robertson, containing 4 papers :—

"Organic structures," by J. M. Robertson (*pp.* 345–350).

"The structures of silicates," by W. H. Taylor (*pp.* 351–360).

"The examination of ternary alloy systems by X-rays," by H. Lipson (*pp.* 361–368).

"Order-disorder phenomena in alloys," by E. T. Goodwin (*pp.* 369–377).

See also Abstracts 1087, 1179, 1199, 1221, 1264, 1268, 1279, 1281, 1327, and

400B. Structural changes in Cu effected by cold rolling and annealing. M. Cook and T. L. Richards.

402B. Structure of γ-mixed crystals in Pd-Mn system. G. Grube and O. Winkler.

403B. Cu-Mn system. G. Grube, E. Oestreicher and O. Winkler.

DENSITY.

See Abstracts 1003, 1023, 1024, 1155.

DIFFUSION AND OSMOSIS.

971. Generalized theory of diffusion. Parts I and II. E. J. Hellund. *Phys. Rev.*, **57**, *pp.* 319–333, *Feb.* 15, 1940.—Part I deals with pressure diffusion. The theory of diffusion in mixtures with more than two components is developed as an extension of the theory of Enskog for binary mixtures. In particular, the various coefficients are evaluated as functions of the binary coefficients of diffusion. Attention is also given to the theory of osmotic diffusion in connection with the Loschmidt experiment. The analysis is carried through in such a manner as to be applicable to Einstein-Bose and Fermi-Dirac gases as well as the Maxwell-Boltzmann Type. In Part II the theory of diffusion in ternary and higher order gas mixtures is completed with the discussion of thermal diffusion. The theory is carried to the point where assumptions about molecular interactions are necessary to obtain quantitative expression of the coefficients. In the special case of elastic spheres the formulae are given in terms of the masses and cross-sections, neglecting, however, the diffraction effects. Author.

See also Abstracts 982, 1203.

ELASTICITY AND PLASTICITY.

972. Motion of an elastic sphere. R. Einaudi. *Accad. Sci. Torino, Atti*, **74**, *Disp. 5a, pp.* 591–618, *July–Oct.*, 1939.—Taking the initial displacement and velocity of every point within the sphere, and the displacement of the surface at all subsequent times as given, the displacement of an arbitrary point in the sphere is given in terms of an infinite expansion in terms of spherical harmonics. The coefficient of each term is the solution of a differential equation of Fuchs' type. The method is applicable if the initial and boundary values, together with a sufficient number of their derivatives, are continuous. R. P.

973. Terrestrial elastic reactions. P. Despujols. *Comptes Rendus*, **210**, *pp.* 206–208, *Feb.* 5, 1940.—The theory developed in a previous paper [see Abstract 4450 (1939)] is applied to determine the displacements in the case of an infinite beam resting either upon two rigid supports or upon a number of parallel linear supports and subjected to earth pressure. J. S. G. T.

974. Stresses in freely falling chimneys and columns. F. P. Bundy. *J. of Applied Physics*, **11**, *pp.* 112–123, *Feb.*, 1940.—A chimney or column is considered as a rigid rod, initially in a vertical position, and hinged at its base. The internal forces and stresses which are developed as the rod falls freely from the vertical position are calculated. It is shown that the inertial reaction forces produce a bending moment which results in a tension on the leading side and a compression in the trailing side of the rod. This tension in the leading side has its maximum value at roughly 0·3 to 0·5 the height of the rod, depending upon its shape and the angle of inclination from the vertical. This tension usually produces a transverse rupture in large falling chimneys or columns, though not always. These transverse ruptures should occur at the point of maximum tension. It is shown that in very tall columns or chimneys the vertical shear stress near the base is sufficient to produce a tension rupture there—and usually does.

The positions of these latter ruptures cannot be predicted accurately in actual cases because of the greatly variable conditions which may exist at the point of support after dynamiting. Calculations are given for the cases of solid columns of uniform cross-section, solid columns of uniformly tapered cross-section, and uniformly tapered chimneys of constant wall thickness. Photographs of actual falling chimneys are presented to check the theory. AUTHOR.

975. Bending of thin, straight rods under a longitudinal compression load, and its application for measuring static elastic constants. O. MEISSER. *Phys. Zeits.*, **40**, *pp.* 551–556, *Sept.* 1, 1939.—If the longitudinal load on a thin rod is increased a little beyond the critical value, the rod will give sideways by an amount which depends very sensitively on the load and on the elastic constants. This fact is used to develop a static method of measuring the elastic constants and, in particular their variation with temperature and other influences. R. P.

976. Natural frequencies of vibrating systems. R. V. SOUTHWELL. *Roy. Soc., Proc. A*, **174**, *pp.* 433–457, *March* 8, 1940.—On the basis of a theorem due to Lord Rayleigh and relating to the effect on the natural frequencies of an added mass, methods are developed whereby lower limits can be imposed upon the frequencies of a specified system. Since upper limits can be imposed on the basis of "Rayleigh's principle," information so obtained is for practical purposes of equal value with an exact solution. The methods can be applied as an extension of the "relaxation" technique, and it is then that their value is revealed most clearly. In this paper attention is confined to continuous systems governed by differential equations, and for these, incidentally, a method is developed whereby specially close estimates of the fundamental frequency can be made if desired. The concluding section of the paper is concerned with the resolution of a paradox presented by Lord Rayleigh's theorem regarding the effect of a constraint. [See also Abstract 934 (1939).] AUTHOR.

977. Proposition that "shearing stress alone is effective in producing elastic failure." J. J. GUEST. *Phil. Mag.*, **29**, *pp.* 289–297, *March*, 1940.—The author surveys work in this field by Taylor and Quinney [see Abstract 843B (1932)], Cook, Nadai, and Gough and Clenshaw, from which he deduces that the diverse results of these authors are strongly against the possible truth of any criterion dependent on shear stress only. Furthermore, any criterion so dependent will necessarily predicate that all materials must have equal yield point stresses in simple tension and in simple compression as the shear stresses in these are identical. All tests of brittle materials, cast iron, stone, concrete, show yield stresses in compression several times greater than those in tension, and it is only in mild and nickel steels, and soft metals, that experiment finds them to be nearly the same. Thus any theory of elastic failure dependent on shear stresses only must be confined to such materials as have equal yield stresses in tension and compression and cannot be of general application. H. H. Ho.

See also Abstracts 991, 992, 993, 1026, 1076, and
420B. Optical strain apparatus with polarization filters. L. Föppl and E. Müller-Lüfft.

HYDRODYNAMICS AND AERODYNAMICS.

978. Fluid motion. Transition from laminar to turbulent flow in a boundary layer. A. FAGE. *Phys. Soc., Reports*, **6**, *pp.* 270–279, 1939.

979. Determination of the projection of least wave resistance. C. FERRARI. *Accad. Sci., Torino, Atti,* **74,** *Disp. 5a, pp.* 675–693, *July–Oct.,* 1939.—A method is given for the determination of the form of the solid of revolution that presents the least wave resistance for a given ratio, viz. maximum section : length of solid, in rectilinear translatory motion with velocity above that of sound in the direction of its axis. The method is based on that already explained by Kármán on the hypothesis that the perturbations produced by the obstacle in the field of motion of the fluid relative to it are so small as to render linear the equations of the motion itself, but not requiring any other simplifying hypothesis and permitting of taking into account the resistance of both the prow and the stern. It may even be possible to apply it to determination of the best arch of finite length. J. J. S.

980. Field of velocity and superficial waves produced by shock and by sinking of a body in a heavy fluid. E. LORENZELLI. *Accad. Sci., Torino, Atti,* **74,** *Disp. 5a, pp.* 694–710, *July–Oct.,* 1939.—A determination is given of the field of velocity produced by a fixed surge with constant range and by a movable surge with variable range, in presence of a free surface at constant pressure treating it similarly to the field produced by the sinking under this surface of an elementary solid of given curvature. In particular, the superficial waves produced by the blow of the elementary solid, falling with known velocity is determined and the waves produced by its consecutive sinking in the heavy fluid considered. J. J. S.

981. General method for studying the commencement of perturbations. Application to heat and hydrodynamics. P. VERNOTTE. *Comptes Rendus,* **210,** *pp.* 42–44, *Jan.* 3, 1940.—Mathematical. A. J. M.

982. Stability and configuration of wakes produced by solid bodies moving through fluids. S. H. HOLLINGDALE. *Phil. Mag.,* **29,** *pp.* 209–257, *March,* 1940.—In Part I the stability of certain types of " one-dimensional " steady flow in an unlimited viscous fluid is investigated by the method of small oscillations. The general result is obtained that the velocity of the oscillations (in the direction of motion of the main flow) is equal to the velocity of the main flow at the point of inflection of the laminar velocity profile. Two profiles of physical interest are considered in greater detail and approximate values obtained for the wavelength of the oscillations. No critical Reynolds number for the transition to instability can be obtained by the method. In Part II photographs have been obtained of both laminar and oscillating wakes produced by models (flat plates and symmetrical aerofoil sections at zero incidence) moving in a tank of water. Oscillations do not occur when the Reynolds number is less than 600 for the flat plate and 1 000 for the aerofoil section, and it is probable that the onset of instability can be considerably delayed by careful elimination of all " residual motions " in the water. The velocity-field in the laminar wake has been measured, and a comparison made with certain results of Goldstein and Fage. Good agreement is obtained, the divergence being appreciable at the edges of the wake, due to the effect of the walls of the tank. Measurements of the wavelength and wave-velocity have been made for various oscillating wakes, and a comparison with the conclusions of Part I attempted. The agreement between theory and experiment is fairly satisfactory, but the comparison is blunted owing to several difficulties of interpretation of the theoretical results. AUTHOR.

See also Abstracts 1058, 1059, 1060, 1061.

KINETIC THEORY OF MATTER.

983. Experimental determination of Boltzmann constant and Loschmidt number. W. C. Michels and S. B. Brody. *Am. Phys. Teacher*, **7**, *pp.* 401–403, *Dec.*, 1939.—Despite the accuracy with which comparatively inexperienced observers may determine the Boltzmann constant and the Loschmidt number by means of Millikan's oil-drop experiment for e and a coulometer determination of the faraday, there are certain distinct benefits for the student in a direct kinetic theory evaluation. A set of experiments is now described for the latter purpose, and includes apparatus for studying the isotherms of CO_2 and for the determination of viscosity. The carrying through of these experiments is claimed to afford students a sense of the reality of the kinetic theory concepts.

H. H. Ho.

See also Abstracts 940, 1005, 1278.

MATHEMATICAL METHODS AND THEORY OF MEASUREMENTS.

984. Matrices of quaternions and representation of Eddington's E-numbers. W. H. McCrea. *Roy. Irish Acad., Proc. A*, **45**, 5, *pp.* 65–71, 1939.

***985. Electrical method for compounding sine functions.** L. R. Maxwell. *Rev. Sci. Instruments*, **11**, *pp.* 47–54, *Feb.*, 1940.—An electrical device is described for evaluating the series $\Sigma A_i \sin a_i x$. For each term in the series there is constructed one compounding element composed of 3 coils; a long solenoid acting as a primary (60-cycle a.c.) within which are mounted 2 short secondary coils, one a rotor (order of 1/5 r.p.m.) and the other a stator. The mutual inductance between the primary and rotor varies as the sine of the angle $a_i x$ of rotation while the primary current is held proportional to A_i. The vector sum of the peak voltages induced in the rotor and stator varies about a constant value proportional to $A_i \sin a_i x$. Thus the variations of the resultant voltage from all of the elements about a constant value are proportional to the sum of the series. A record of the sum is made on photographic paper by means of a vacuum-tube voltmeter circuit. Satisfactory tests have been made on a machine containing 2 elements. The application to structure determinations of gas molecules by electron diffraction is presented. Author.

***986. Principles of a mechanical method for calculating regression equations and multiple correlation coefficients and for the solution of simultaneous linear equations.** T. E. W. Schumann. *Phil. Mag.*, **29**, *pp.* 258–273, *March*, 1940.—In order to avoid the tedium of the numerical computation of multiple correlation coefficients, a machine has been devised which provides a mechanical means of determining the constants of an equation of regression and hence of multiple correlation. Where a fairly large number of variables is involved the labour of numerical calculation is excessive, and an estimate of the relative times required for numerical and mechanical computation respectively shows that the machine should prove itself to be of great practical value. Satisfactory experimental results were obtained with a preliminary rough model. In a slightly modified form the machine may also be used for the solution of sets of simultaneous linear equations. Author.

See also Abstracts 1152, 1153, 1280, and
452B. Cathode-ray oscillograph as an algebraic-curve tracer. S. Tanaka and S. Nagai.

MECHANICS, CLASSICAL.

987. Ricochet shot with small-calibre gun. P. Kunze. *Phys. Zeits.*, **40**, *pp.* 643–644, *Oct.* 15, 1939.—Description of an apparatus for measuring what Ramsauer has called the ricochet shot of a gun of small calibre. J. J. S.

MECHANICS, QUANTUM.

988. Equations of motion of the first order in wave mechanics. M. Schönberg. *Comptes Rendus*, **209**, *pp.* 985–987, *Dec.* 27, 1939.—In addition to the wave equations for particles of arbitrary spin which were given by Dirac, there exists a second type, of which the form is briefly indicated. R. P.

989. Stationary states of scalar and vector fields. H. Snyder and J. Weinberg. *Phys. Rev.*, **57**, *pp.* 307–314, *Feb.* 15, 1940.—In the presence of an electrostatic field (but not for a static world scalar or magnetostatic field) the stationary solutions of the quadratic relativistic wave equation for scalar particles do not form an orthonormal set. In spite of this they may in general be used to introduce normal co-ordinates for the quantum theory of this field. If the wave field and its canonical conjugate are expanded in terms of these stationary solutions then the commutation laws for the amplitudes follow from the wave field commutators and the assumption of the integrability of the classical wave equation for arbitrary initial function and time derivative. Parallel considerations are applied to the vector field. An alternative method is described that involves the introduction of orthonormal functions and the construction of a "particle Hamiltonian." [See following Abstract.] Authors.

990. Existence of stationary states of the mesotron field. L. I. Schiff, H. Snyder and J. Weinberg. *Phys. Rev.*, **57**, *pp.* 315–318, *Feb.* 15, 1940.—For some electrostatic potentials, such as that represented by a sufficiently deep well, the Pauli-Weisskopf wave equation has complex frequencies. It is shown that when this happens the quantized field Hamiltonian can no longer be diagonalized. Some points of similarity and difference between this theory and the Dirac positron theory are discussed. [See preceding Abstract.] Authors.

See also Abstracts 924, 925, 948, 984, 1220, 1226, 1280.

PRESSURE.

991. Absolute measurements in the pressure range up to 30 000 kg./cm². P. W. Bridgman. *Phys. Rev.*, **57**, *pp.* 235–237, *Feb.* 1, 1940.—A brief summary of measurements to establish a pressure scale and an absolute compressibility for a new high-pressure range. The electrical resistance of the manganin pressure gauge was calibrated with reference to a fixed point, the transition pressure between two modifications of Bi [see Abstract 1799 (1938)], which was determined accurately. With this calibration a new fixed point, the freezing pressure of Hg at 30°, was found to be 13 715 kg./cm²., and from this pressure scale the absolute compressibility of pure Fe was established and expressed by an equation. [See following Abstract.] N. M. B.

992. Compressions to 50 000 kg./cm². P. W. Bridgman. *Phys. Rev.*, **57**, *pp.* 237–239, *Feb.* 1, 1940.—A preliminary summary of the numerical results of a series of measurements with new apparatus [see Abstract 1798 (1938)], improved by two stages of support, of the volume decrements

for 39 binary cubic compounds and for the more compressible elements S, Se, Te, In, Sb, and Bi up to 50 000 kg./cm.^{2}. [See preceding Abstract.] N. M. B.

***993. Deformation of barometer membranes.** F. Charron. *Comptes Rendus*, **209**, *pp.* 983–985, *Dec.* 27, 1939.—The forces acting in a deformed corrugated membrane of the barometer type are discussed, and an equation for the equilibrium of the membrane is obtained. This is solved for two extreme cases, according to whether $e^2\sin\beta/L^2\cos^2\beta$ is large or small compared with unity. Here L is the width of the corrugations, e the thickness of the membrane, and 2β the angle between the two flanks of a corrugation. If this ratio is large, the membrane shows a behaviour which makes it very unsuitable for practical purposes. If the ratio is small, the linear displacement of the centre is proportional to the pressure difference. R. P.

***994. Automatic distributor of reduced pressure and of compressed gas for physiological usage or for other applications.** J. A. Thomas. *Comptes Rendus*, **209**, *pp.* 1010–1013, *Dec.* 27, 1939.—In many perfusion and other physiological experiments it is necessary to have an automatic apparatus which will produce a vacuum, or at least a low pressure, as well as an increase of pressure. A pumping apparatus is described in which there are two reservoirs—one of which is on the low-pressure side and the other on the high-pressure side. The apparatus is worked by an electric motor. It is somewhat complicated and for full details of its construction the original paper, where a complete diagram is given, must be consulted. It is possible to adjust the operation of valves so that different degrees of pressure reduction or increase can be obtained. By other adjustments the period of high pressure can be made to occur either synchronously or alternatively with that of low pressure. The length of these phases of high and low pressure can also be adjusted. [**Errata** *ibid.*, 210, *p.* 814, *Jan.* 8, 1940.] G. G.

995. Gettering powers of various metals for H_2, O_2, N_2, CO_2 and air. L. F. Ehrke and C. M. Slack. *J. of Applied Physics*, **11**, *pp.* 129–139, *Feb.*, 1940.—Measurements of the "gettering" or clean-up ability of Al, Mg, Th, U, Zr, Ba and misch metal (active constituents largely Ce and La) for the common gases were made. In most cases the measurements were quantitative and represent gettering powers unassisted by an electric discharge or other source of ions. The effect of temperature conditions on the gettering and keeping properties of several of the getters is given. The superior gettering powers of the diffuse layers produced by vaporizing the getters in the presence of a gas, as compared with those of the bright getter deposits produced in a high vacuum were confirmed. Ba and misch metal were found to be the most active of the materials tried, and the convenient forms in which Ba is now commercially obtainable would seem to make it first choice for most work, though it is not effective in the presence of Hg vapour. Mg and Al showed little activity without the presence of a discharge. Th and U showed considerable activity for H_2 and O_2 but the high temperatures needed for flashing make them rather inconvenient to use. Authors.

RELATIVITY AND ETHER.

996. Measurement of velocity with atomic clocks. H. E. Ives. *Science*, **91**, *pp.* 79–84, *Jan.* 26, 1940.—An atomic clock is defined as

a hydrogen ion emitting pulses of radiation, the ion being in motion in a canal ray. The frequency of the radiation varies with the velocity, v_1 of the ion according to the rule $\nu = \nu_0(1 - v^2/c^2)^{1/2}$. The Fitzgerald contraction is also assumed for the motion of measuring rods. The formulae for relative velocity which can be deduced from these hypotheses are worked out first on the assumption that two marks on the moving object successively pass a given clock and secondly, that the object successively passes two given synchronized clocks. The author also explains why he believes that the Sagnac experiment leads to a luminiferous ether. G. C. McV.

SOLUTION.

997. Molecular interaction in solution. P. Girard and P. Abadie. *Comptes Rendus*, **209**, *pp.* 874–877, *Dec.* 11, 1939.—The experimental study of the absorption of solutions of dipoles submitted to an alternating electric field (temperature being kept fixed) has shown the influence, varying with their structure, which the non-polar molecules of the diluent (themselves neither absorbing nor dispersing) have on the absorption and on the dispersion. It is the comparison of the dispersion and of the absorption of such solutions with those of corresponding pure liquids which shows this important influence. In fact instead of the variations of ϵ' and of ϵ'' the variations, in function of λ, of $\epsilon'' - \epsilon_0/\epsilon' - \epsilon_0$ are taken account of on dispersion, and those of $\epsilon'/\epsilon'' - \epsilon_0$ are considered on absorption. The authors thence derive a method (necessarily comparative) for the experimental study of molecular interactions. This is the first possibility offered of penetrating directly into this unexplored domain, and its importance can be foreseen. J. J. S.

998. Empirical relation between solubility of slightly soluble electrolytes and dielectric constant of the solvent. J. E. Ricci and T. W. Davis. *Am. Chem. Soc., J.*, **62**, *pp.* 407–413, *Feb.*, 1940.—The activity coefficient of a salt in saturated solution has been noted in many cases to be practically constant and independent of the dielectric constant of the medium. This observation leads to an empirical relation between the solubility of a slightly soluble electrolyte and the dielectric constant of the solvent which makes it possible to predict the solubility of a salt in other media from the solubility in water without knowledge of ionic diameters. Calculated and observed solubilities are compared ; the agreement is found in general to be satisfactory at least as to the order of magnitude and to be on the whole as good as that obtained by the Born equation where ionic diameters have been estimated. Authors.

999. Activity coefficients of strong electrolytes. Part II. P. van Rysselberghe and S. Eisenberg. *Am. Chem. Soc., J.*, **62**, *pp.* 451–452, Feb., 1940.—A corrected formulation [see Abstract 51 (1940)].

1000. Solubility of calcium oxalate in salt solutions. H. Shehyn and D. B. Pall. *J. Phys. Chem.*, **44**, *pp.* 166–171, *Feb.*, 1940.—The solubility of CaC_2O_4 in NH_4Cl, $(NH_4)_2SO_4$ and Na_2SO_4 solutions has been determined at room temperature, 50°C., and 95°C., and over a range of salt concentration. The solubility in NH_4NO_3 solutions is given at room temperature only. The solubilities at room temperatures are correlated using the rule of ionic strength, and found to be consistent among themselves, and also with outside data for NaCl solutions. Authors.

1001. Solubilities of inorganic compounds in H_2O and D_2O. R. D. Eddy and A. W. C. Menzies. *J. Phys. Chem.*, **44**, *pp.* 207–235, *Feb.*, 1940.—The solubilities in ordinary water of NaCl, $NaBr.2H_2O$, NaBr,

$NaI \cdot 2H_2O$, $NaI \cdot xH_2O$, NaI, $Na_2SO_4 \cdot 10H_2O$, $Na_2SO_4 \cdot 7H_2O$, Na_2SO_4, KBr, KI, $BaCl_2 \cdot 2H_2O$, $BaCl_2 \cdot H_2O$, CdI_2, and $HgCl_2$ have been studied, chiefly by a method proposed by Menzies [see Abstract 3503 (1936)], over their ranges of existence within the interval 0°C. to 105–180°C. A similar study has been made of the analogous systems in D_2O. The resulting molal solubility values and their differences in the two systems have been tabulated for rounded temperatures at intervals of 5 deg. C. Differences were found to range from $-2{\cdot}0$ to $+42\%$. From the intersection of solubility curves, the transition temperatures of six hydrates and six analogous deuterates have been evaluated and compared. These were all incongruent melting points, and were sometimes lower and sometimes higher for deuterates than for their analogous hydrates. It is predicted that the same will be true for congruent melting points of such compounds. The existence has been uncovered of a new hydrate of NaI, and of the analogous deuterate. AUTHORS.

See also Abstract 1014 and
401B. Solubility of lead in tin. A. Stockburn.

SURFACE PROPERTIES.

1002. Discontinuities in adsorption processes. H. H. CHAMBERS AND A. KING. *Chem. Soc., J., pp.* 156–166, *Feb.*, 1940.—A new technique for measuring the adsorption of gases by solids described in a previous paper [see Abstract 997 (1939)] has been applied to the problem of discontinuous adsorption. Several criticisms of the method are shown to be invalid, and a preliminary investigation of the adsorption of vapours by various solids is described. New and conclusive evidence for the existence of discontinuous adsorption has been obtained with several different vapours on charcoal, silica gel, chromic oxide, and chabasite. Allmand and Burrage's general conclusion that vapours are adsorbed discontinuously by complex solids is confirmed, and is shown to be true also of the crystalline material, chabasite. AUTHORS.

1003. Adsorption isotherms for mobile monolayers. W. BAND. *J. Chem. Phys.*, **8**, *pp.* 178–180, *Feb.*, 1940.—A 3-dimensional gas is pictured in contact with a liquid, forming at the interface a mobile monolayer. The density of the monolayer is maintained in equilibrium with the pressure of the gas. An equation is deduced giving as a function of temperature, the gas pressure which is just sufficient to initiate condensation in the monolayer. The only physical parameters involved in the relationship are the mass of the molecule and the heat of evaporation per molecule from the completely clustered monolayer. The fatty acids which exhibit monolayers with negligible external gas pressures, must have heats of evaporation greater than about 100×10^{-14} erg. Molecules as small as 20 atomic mass units and heats of evaporation less than about 75×10^{-14} erg should require pressures of the order of 10^{-2} atm. An adsorption isotherm equation is found for monolayer concentrations less than the saturation value. Its form is similar but not identical with Langmuir's isotherm for immobile monolayers. AUTHOR.

1004. Adsorption of water vapour by gelatin. S. E. SHEPPARD, R. C. HOUCK AND C. DITTMAR. *Kodak Research Lab., Comm. No.* 732. *J. Phys. Chem.*, **44**, *pp.* 185–207, *Feb.*, 1940.—The sorption of water vapour by dry gelatin has been studied at 25°C., using two types of "ash-free," purified gelatin, viz. "lime-processed" gelatin, isoelectric point *p*H 4·8, and "acid-processed" gelatin, isoelectric point *p*H 8·2.

Little difference was observed until the vapour pressure approached saturation, when the " lime-processed " material showed greater adsorption. The adsorption (and desorption) isotherms are curves of double flexure, resembling those obtained with cotton cellulose, wool, silk, and other fibrous materials. The moisture regain varies with pH (of the sol at coating) decreasing from high to low pH, but no minimum was found at the isoelectric point. The electrical conductivity increases with moisture content, as found for cotton and wool. Over a considerable range the logarithm of the conductance is a linear function of the moisture content. The electrical conductance shows a decided minimum at the isoelectric point. The results are discussed in connection with X-ray diffraction studies of the structure of gelatin. The sorption of water vapour appears to be largely conditioned by the fine structure of the xerogel, but this again is conditioned by chemical interactions of the protein molecules. AUTHORS.

1005. Surface tension and Lindemann frequency. L. SIBAIYA AND M. R. RAO. *Indian Journ. Phys.*, **13**, *pp.* 293–298, *Aug.*, 1939.—Assuming as in the theory of liquid viscosity by Andrade that the molecules of a liquid at its melting-point continue to oscillate with Lindemann frequency ν, the surface tension γ of a liquid is here considered to be given by the energy of the oscillating molecules in unit area of its surface of unimolecular thickness. The relation to which this assumption leads, viz., $\gamma = k^2 m \nu^2$, where m is the mass of the atom or molecule, has been examined in the light of available data for 45 substances including elements and compounds ; and it is found that the constant k has a mean value 2·34. Experimental results, which show that viscosity influences the rotational " wings " in light-scattering, necessitate a view-point of viscosity independent of relative motion ; assuming tentatively that the total momentum transferred per oscillation by the molecules across unit area gives the value of viscosity, and inserting the value of k obtained from surface tension data therein, Andrade's expression for viscosity is shown to follow quantitatively. The variation of surface tension with temperature is explained on the basis of Macleod's relations ; several empirical relations requiring verification have been obtained. AUTHORS.

1006. Detection of double salts in solution by surface tension. G. ARCAY AND M. MARCOT. *Comptes Rendus*, **209**, *pp.* 881–882, *Dec.* 11, 1939.—The determination of the surface tension of mixtures of KCl and $HgCl_2$ solutions in various proportions shows the existence in solution of the double salts $KCl \cdot 2HgCl_2$, $KCl \cdot HgCl_2$, and $2KCl \cdot HgCl_2$. A. J. M.

1007. Studies of solutions of hydrocinnamic acid and of lauryl sulphonic acid with the film balance. J. W. MCBAIN AND W. V. SPENCER. *Am. Chem. Soc., J.*, **62**, *pp.* 239–244, *Feb.*, 1940.—The film balance when applied to ordinary solutions yields a complex series of novel results which bear but little relation to previous conceptions derived from analogy with insoluble monomolecular films floating on water ; and thus a new field is open to investigation. Particularly striking is the fact that the various phenomena of surface pressure and of time frequently pass through a high maximum in an intermediate range of dilute solution. Again, whether a pellicle forms or not depends both upon the concentration and the degree of compression of the surface. Some substances apparently never form it. When it is formed and sufficiently compressed, the final pressure is characteristic only of the substance. On the other hand, the initial pressure may be greatest where the final pressure vanishes. [See following Abstract.] AUTHORS.

***1008. Observations of surface tension in the PLAWM trough.** J. W. McBain, J. R. Vinograd and D. A. Wilson. *Am. Chem. Soc., J.*, **62**, *pp.* 244–248, *Feb.*, 1940.—The PLAWM (Pockels-Langmuir-Adam-Wilson-McBain) trough, consisting of a film balance divided into two compartments by a watertight flexible float, has been applied to solutions of hydrocinnamic acid, potassium laurate, sodium butylbenzene sulphonate and lauryl sulphonic acid. In conformity with data by other recognized methods, supplied to the authors by other workers, it has been shown that the surface tension of solutions of hydrocinnamic acid is not fully established until after periods of time enormously greater than those expected from classical diffusion processes. The existence of Type III curves with a minimum has been critically established. In these a trace of solute reduces the surface tension of the solvent to a fraction of its value, whereupon further small addition raises the surface tension again to a still low maximum or constant value. This has been shown for lauryl sulphonic acid (and also for sodium butylbenzene sulphonate), again in conformity with data supplied by other workers. With potassium laurate addition of alkali appears to lower the flat maximum to the value of the minimum. It is pointed out that the PLAWM trough will be invaluable in repeating and interpreting the surprising results obtained with clean solutions of soluble substances with the Pockels-Langmuir-Adam film balance. [See preceding Abstract.] Authors.

1009. Surface tensions of methyl acetate solutions. J. W. Belton. *Faraday Soc., Trans.*, **36**, *pp.* 493–496, *March*, 1940.—The surface tensions of aqueous methyl acetate solutions have been measured to within 0·3%, and the surface adsorption calculated. The effect of the addition of sucrose has been investigated, and it is found that the amount of methyl acetate in the surface is increased, but that the increase is independent of the amount of sucrose added; the amount of water adsorbed is also shown to be independent of the amount of sucrose. Author.

1010. Crystallization of thin gold films by electronic bombardment. D. A. Was and T. Tol. *Physica*, **7**, *pp.* 253–254, *March*, 1940. *In English.*—Ultramicroscopical observations prove that thin gold films are changed by exposure to electronic rays. [See Abstract 1953 (1939).] Authors.

1011. X-ray and optical properties of built-up films. S. Bernstein. *Am. Chem. Soc., J.*, **62**, *pp.* 374–378, *Feb.*, 1940.—X-ray refraction corrections and possible optical phase-change corrections fail to account for the discrepancy between X-ray and optical measurements of the thickness of built-up stearate films. The results indicate that the discrepancy must be explained in terms of the film structure. X-ray measured thicknesses of barium-copper stearate and barium stearate films are greater than the corresponding optical measurements; X-ray measured thicknesses of copper stearate films are less than the corresponding optically measured thicknesses. Measurements of a set of barium-copper stearate films of varying proportions of barium stearate and copper stearate show that the film thickness varies greatly with film composition and that a change in X-ray measured thickness is not accompanied by a change in optically measured thickness of the same magnitude. Skeletonized and unskeletonized films of the same original composition were found to have the same X-ray grating-space. Metal stearate films give only zero layer-line reflections. An ethyl stearate film showed other than zero layer-line reflections in addition to those of the zero layer line. A film structure is

suggested which is consistent with the X-ray and optical measurements and with reported contact potential measurements. AUTHOR.

1012. Evaporation of water through unimolecular films. F. SEBBA AND H. V. A. BRISCOE. *Chem. Soc., J., pp.* 106–114, *Feb.*, 1940.—A new technique has been developed for comparative measurements of the rate of evaporation of water through unimolecular films into a constant current of dry air under conditions of controlled and measured surface pressure. The device used is named the " evaporant", and its construction and use are described. It is found that the resistance offered by films to the evaporation of underlying water is a highly specific property : some films, e.g. of egg albumin, cholesterol, oleic acid and elaidic acid, offer practically no resistance under any conditions, whereas stearic acid, brassidic acid, arachidic acid, cetyl alcohol, octadecyl alcohol, and *n*-docosanol under suitable conditions can reduce evaporation to a very small fraction of that from a free water surface. The resistance becomes substantial only above a critical surface pressure which is characteristic for each substance and is, in general, substantially greater than that at which the film becomes relatively incompressible. Hydrophilic groups in the chain appear to reduce or eliminate the resistance. Increase of chain length increases resistance and lowers the critical pressure at which substantial resistance sets in. The resistance of a film cannot be correlated with its physical state ; e.g. the solid film of albumin offers no resistance, but the liquid film of cetyl alcohol offers great resistance to the passage of water. It is suggested that an explanation of these phenomena may require the assumption that unimolecular films contain dissolved water and are in equilibrium with a solution of the film-forming substance in the water substrate. Films of " indicator oil", even 100 molecules thick, offer less resistance to evaporation than typical " waterproof " unimolecular films such as that of cetyl alcohol. [See following Abstract.] AUTHORS.

1013. New " ageing " phenomenon in unimolecular films on water. F. SEBBA AND H. V. A. BRISCOE. *Chem. Soc., J., pp.* 128–131, *Feb.*, 1940.—In applying the technique of the " evaporant", already described [see preceding Abstract], to comparative determinations of the rate of evaporation of water into an air current from free and from film-covered water surfaces, an " ageing effect " has been discovered whereby compressed films, e.g. of *n*-docosanol or arachidic acid, which when freshly formed and compressed largely reduce the rate of evaporation from the water surface, become much more permeable to water if they are first allowed to lie for some time on the water surface, especially if the ageing is effected at a relatively low surface pressure. The magnitude of the ageing effect varies directly with time of ageing and inversely with the surface pressure during ageing. A film of *n*-docosanol when freshly formed and compressed to a surface pressure of 47 dynes/cm. reduces evaporation to about 2% of that from the clean water surface ; if, however, the film is aged on the water surface at zero pressure for 20 hours and then compressed to 47 dynes/cm., the evaporation through it exceeds 95% of that from the free water surface. The phenomenon is explained on the hypothesis that in an uncompressed film the single molecules, being in active motion and free to associate, gradually do so in pairs, forming double molecules having a hydrophilic alcoholic group at each end, which, being thus akin to the single molecules of dihydroxy-alcohols, lie and remain flat upon the water surface and so greatly enhance the permeability of the film to water. In accordance with this hypothesis, it is found that a film, when compressed

after being aged at low pressure, occupies a substantially greater area than when compressed to the same pressure before ageing, and is also more soluble. AUTHORS.

1014. Variation of solubility of unimolecular films with surface pressure, and its effect on measurement of true surface pressure. F. SEBBA AND H. V. A. BRISCOE. *Chem. Soc., J., pp.* 114–118, *Feb.*, 1940.—Measurements of the surface pressure developed in films in presence of excess of the film-forming substance, made with a Harkins-Anderson surface balance, showed that, contrary to the belief of previous workers, this pressure is not constant. Investigation of its variation with time for cetyl alcohol on water at *p*H 7·0 disclosed curious changes which are attributed to the combined effect of progressive solution of the film and varying immersion of the floating islands of excess alcohol. After the film has been swept off completely, bubbling of air through the water brings a film of cetyl alcohol to the surface, proving that solution has occurred. With octadecyl alcohol the pressure rises to a maximum and then falls progressively. This effect is not observed if the water is previously saturated with the alcohol. Stearic and palmitic acids are similarly soluble, the latter very rapidly, in water at *p*H 7·0, but much less soluble in *N*/100-HCl. The solubility of a mixed film of stearic acid and cetyl alcohol (1 : 5) is less than that of either substance alone. Soluble films were also given by cholesterol, by proteins, and by oleic, elaidic, brassidic, and erucic acids. The solubility of arachidic acid was slight, and that of *n*-docosanol barely detectable. It is suggested that unimolecular films in general may be regarded as saturated solutions of water in the film-forming substance in pseudo-equilibrium with underlying solutions of that substance in water which progressively decrease in concentration with depth. AUTHORS.

1015. Theory of formation of protective oxide films on metals. Part II. N. F. MOTT. *Faraday Soc., Trans.*, **36**, *pp.* 472–483, *March*, 1940.—This paper is a continuation of previous work [see Abstract 4240 (1939)] and deals with mechanisms for the growth of oxide films, detailed calculations of film growth, protective films on alloys, thick films, and a logarithmic law of growth due to recrystallization. It is shown that for a certain range of thicknesses, the logarithmic law of growth connecting the thickness x with the time t is $x = \mathrm{K} \log (at + c)$, where K, a and c are constants. Such a law gives a negligible rate of growth above a certain thickness, which depends very little on the temperature. The conditions are determined under which the more familiar parabolic law $x^2 = \text{const.}\ t$ can be expected, and also those by which the rate of growth given by this law falls off for thick films to one given by $x^3 = \text{const.}\ t$. The theory is then applied to the formation of protective films on alloys and to other processes which may lead to a logarithmic law of growth. H. H. Ho.

1016. Monolayers of a long-chain ester sulphate. E. STENHAGEN. *Faraday Soc., Trans.*, **36**, *pp.* 496–499, *March*, 1940.—The properties of monolayers of sodium docosyl sulphate on different substrates are described and discussed. AUTHOR.

1017. Wettability of solid surfaces. H. DEVAUX. *Comptes Rendus*, **210**, *pp.* 27–29, *Jan.* 3, 1940.—The phenomenon is described in detail, and the essential similarity of a film of water on a new glass surface (as of a newly blown glass vessel) to a film of oil on water emphasized. Its dependence on the nature of the surface, which may vary from point to point with the polarity of the molecules at the point, is discussed. [See Abstract 3954 (1933).] C. A. S.

***1018. New method of investigating lubricating oils and their properties.** P. L. du Noüy. *Comptes Rendus*, **209**, *pp.* 101–102, *Jan.* 15, 1940.—An instrument for determining and registering surface tension automatically has been constructed. In using the apparatus for the investigation of the nature and properties of oils, the surface of H_2O is touched with a fine glass point first dipped in the oil. There is a decrease in surface tension of 6–12 dynes, which then remains constant. The impure surface is then touched with a glass point dipped in oleic acid. There is a further fall in surface tension of 20–30 dynes, but the value gradually increases again. The extent of the increase depends on the nature of the oil. With vaseline, which contains no polar groups and is a poor lubricant, the rise is very small (3–5 dynes), but with a good motor oil the rise is 15–20 dynes in 2–3 hours. The phenomenon is due to the adsorption of the highly polar molecules of oleic acid by the oil. Filtration of a motor oil through paper removes its lubricating properties. A. J. M.

1019. Mechanism of boundary lubrication suggested by static friction of esters. A. Fogg. *Phys. Soc., Proc.*, **52**, *pp.* 239–245, *March*, 1940.—The note gives the results of static friction measurements of steel surfaces lubricated with series of methyl and ethyl esters. The series of ethyl esters was chosen to obtain a relation between coefficient of friction and molecular weight and an unexpected feature of the relation obtained is a maximum value of coefficient of friction at a molecular weight of about 120. A suggested explanation of this phenomenon is given by making certain assumptions regarding the structure and method of attachment of the molecules to the surface. On the basis of these assumptions, the behaviour of a series of methyl esters was predicted before making tests, and the results of the tests subsequently carried out agree with the forecast. Author.

1020. Motion of mercury index in capillary tube. Part II. G. D. Yarnold. *Phys. Soc., Proc.*, **52**, *pp.* 191–195, *March*, 1940.—The simple theory of the motion of a liquid index given in a previous paper [see Abstract 2746 (1938)] is in general agreement with observation, and, if accepted, provides an interesting method for the determination of the coefficient of viscosity of the liquid. Experiments on the motion of mercury indexes in soft glass tubes previously described, and also in pyrex and quartz tubes described in the present communication, yield values of the viscosity consistently 6 or 7% higher than the accepted value. The suggestion has been tested that the discrepancy is in some way connected with the electrification of the Hg resulting from its motion. Although the production of electrification clearly affects the motion of a single index, it is shown that a corresponding error in the determination of the viscosity from observations of a number of indexes is eliminated by the mode of calculation. Experiments made to discover whether electrification has any effect on the flow of mercury in a viscometer give a negative result. The discrepancy, therefore, remains unexplained, and doubts are in fact thrown on the validity of the assumptions underlying the theory. [See following Abstract.] Author.

1021. Electrification of mercury indexes in their passage through tubes. G. D. Yarnold. *Phys. Soc., Proc.*, **52**, *pp.* 196–201, *March*, 1940.—The electrical charge developed by an index is found to be a function of its length and velocity and to vary widely with the insulating properties of the material of the tube. It appears that an index moving at a constant velocity becomes charged to a steady high potential, characteristic of the tube,

at which the rate of leakage is equal to the rate of generation of charge. The disturbing effect of the method of measurement on the charge to be measured is discussed. A description is also given of a subdivided air condenser having high insulation and a total capacity of approximately 24 000 cm. [See preceding Abstract.] AUTHOR.

See also Abstracts 995, 1155, 1157, 1194, 1325, 1328 and 393B. Static friction of lubricated surfaces. A. Fogg and S. A. Hunwicks.

TIME.

1022. Periodic use of summer-time and winter-time. E. ESCLANGON. *Comptes Rendus*, **209**, *pp.* 967–969, *Dec.* 27, 1939.—The midday of clocks should also mark the middle of the day, but this is impossible for two reasons, since the actual midday varies with longitude over France, etc., and the introduction of summer-time has made an arbitrary change. Custom makes "morning" to mean the time between rising and midday of the clocks, and "afternoon" the time between this and dinner-time; and these two intervals are very unequal. The law of 24th May, 1923, complicates this further, and the author urges that the maximum of daylight would be available if the months of October and March were used for the changing to and from summer-time; he suggests further that (at Paris) the day begin at 6hrs., and if summer-time were introduced then, the nominal hours of the day would be 7^h and 19^h, and they would all be included in daylight. Similarly for 1st Nov., for winter-time the daylight hours would nominally be 7^h and 18^h. A. S. D. M.

VISCOSITY AND FRICTION.

1023. Viscosity of solutions of electrolytes as a function of concentration. Part VI. G. JONES AND R. E. STAUFFER. *Am. Chem. Soc., J.*, **62**, *pp.* 335–337, *Feb.*, 1940.—The absolute densities and relative viscosities of many solutions of KBr have been determined at 0° and of solutions of $LaCl_3$ at 25° and 0°. These results confirm the Root equation for densities, the Jones and Dole equation for viscosities and the Falkenhagen and Vernon equation for the influence of the interionic attraction on the viscosity. [See Abstract 1970 (1937) and following Abstract.] AUTHORS.

1024. Viscosity of solutions of electrolytes as a function of concentration. Part VII. G. JONES AND J. H. COLVIN. *Am. Chem. Soc., J.*, **62**, *pp.* 338–340, *Feb.*, 1940.—The absolute densities and the relative viscosities of many solutions of $AgNO_3$, K_2SO_4 and K_2CrO_4 have been determined at 0° and at 25°. These results confirm the Root equation for densities, the Jones and Dole equation for the viscosities, and the Falkenhagen and Vernon equation for the influence of interionic attraction on the viscosity. These results do not confirm Simon's proposed law that isomorphous substances have the same influence on the viscosity. [See preceding Abstract.] AUTHORS.

1025. Viscosity of Ne, H_2, D_2 and He. A. VAN ITTERBEEK AND O. VAN PAEMEL. *Physica*, **7**, *pp.* 265–266, *March*, 1940. *In English.*—Measurements were made of the viscosity of Ne, D_2, H_2 and He as a function of the temperature, at room temperature and at temperatures obtainable with liquid O_2 and liquid H_2. The results are discussed. The viscosity is computed in reduced co-ordinates and it is found that the data obtained for Ne and A [see Abstract 5009 (1938)] fit one and the same curve. This curve is also coincident with the curve computed by Weber [see Abstract 2758 (1939)] for a great number of ordinary gases. The curves obtained

for H_2 and He have undergone a parallel displacement relative to the general viscosity curve obtained for the ordinary gases, which are not submitted at low temperatures to quantum corrections. It is now shown moreover, that the extrapolation made by Weber from his curve is not in agreement with the experimental results. In accordance with measurements previously made in this laboratory it is again stated that η_{D_2}/η_{H_2} decreases continuously with decreasing temperature (1·40 at room temperature, 1·24 at liquid H_2 temperatures.) AUTHORS.

*1026. **Coni-cylindrical viscometer for measuring visco-elastic characteristics of highly viscous liquids.** A. R. LEE AND J. B. WARREN. *Journ. Sci. Instruments*, **17**, *pp.* 63–67, *March*, 1940.—A description is given of an absolute viscometer of the rotating cylinder type, which has been constructed for the purpose of studying the fundamental flow characteristics of bituminous road binders. With this instrument, viscosities from 10^3 to 10^8 poises can be accurately measured, and a value for the elastic recovery of the material under known conditions of shear, stress and temperature can be obtained. AUTHORS.

1027. Liquid drops. L. D. MAHAJAN. *Indian Journ. Phys.*, **13**, *pp.* 299–304, *Aug.*, 1939.—A general mathematical relation between the life of the drops floating on the surface of the same liquid and the viscosities of the mother liquid and of the surrounding medium is deduced, which is applicable for all viscosities and under all conditions. AUTHOR.

See also Abstracts 1005, 1019, 1020, 1200.

ASTRONOMY AND ASTROPHYSICS.

ASTRONOMICAL APPARATUS AND OBSERVATORY EQUIPMENT.

*1028. **Photo-electric photometer.** G. E. KRON. *Lick Observat., Bull. No.* 499, *pp.* 53–57, *rec. Feb.*, 1940.—Full details are given of a new photo-electric photometer, employing d.c. amplification, which has been designed and constructed for use with the 36-in. refractor of which it now forms part of the permanent auxiliary equipment. [See Abstract 1053 (1940).] A. H.

COMETS AND METEORS.

1029. Mean chemical composition of meteoritic accretion. F. G. WATSON, JR. *J. Geol.*, **47**, *pp.* 426–430, *May–June*, 1939.—From a discussion of the relative number and mass of metallic and stony meteorite falls, the ratio of mass accretion is considered to lie between 2 : 1 and 1 : 4. Since no precise value for the ratio is apparent, the mean composition of meteoritic accretion is computed for a range of ratios. AUTHOR.

See also Abstract 927.

COSMOGONY.

1030. Age of the solar system. C. POPOVICI. *Comptes Rendus*, **210**, *pp.* 39–42, *Jan.* 3, 1940.—An upper limit for the age of the solar system is calculated from the secular variations in the orbital elements of the planets produced by the mechanical repulsive action of the sun's radiation. The observed eccentricities and sidereal periods of Mercury and Venus fix the

extreme limit at which Mercury could have been left by the contraction of the primitive solar nebula as 3×10^{15} yr. ago. This limit is reduced to 22×10^{11}yr., however, when the original high temperature of the sun is taken into account. This figure falls between that of Perrin on the condensation theory ($1{\cdot}1 \times 10^{11}$ yr.) and that given by the annihilation of matter theory ($1{\cdot}5 \times 10^{13}$ yr.) A. Hu.

1031. Cosmological theories. E. A. Milne. *Astrophys. J.*, **91**, *pp.* 129–158, *March*, 1940.—The present report is mainly concerned with a careful analysis of the fundamental ideas, methods, and postulates which underlie current approaches to the cosmological problem. In particular, the methods of general relativity and the author's kinematical relativity are contrasted. In the later method all the fundamental notions ("uniform time," "rigid length scale") are carefully scrutinized and emphasis is laid on the methods by which two arbitary observers can set up "congruent" clocks and distance measures by dispatching and receiving light-signals. A *linear equivalence*, defined as a class of observers possessing congruent clocks, is then analysed. This leads to the consideration of the two scales of time t and $\tau = t_0 \log t/t_0 + t_0$, such that a uniform motion equivalence in the scale of t becomes one at relative rest in the scale of τ. The physical significance of the two scales of time are then further discussed. The methods by which the dynamical equations of motion are to be set up by projecting a "free" test particle in the presence of a density distribution and specified equivalence are then considered. The fundamental problem here is the determination of the motion of a free particle for an equivalence satisfying the *cosmological principle*, i.e., the case when the equivalence is such that the statistical description of the whole equivalence from any one member of the equivalence coincides with that from any other member. The solution of the cosmological problem to which the consideration of this problem leads is then discussed; particular attention is here given to the degree of arbitrariness which is left at each stage of the solution of the problem and how the arbitrariness is then later removed. The kinematic arguments are shown to lead to (1) the law of inertia for a substratum (i.e. a density distribution satisfying the cosmological principle), (2) the existence of "gravitational" mass, and (3) the inverse-square character of "gravitational force." Further problems which can be treated by the methods outlined in this paper are also indicated. The importance of the two time scales, that of t and that of τ, in answering questions about the universe (e.g. whether the universe is expanding or is nonexpanding) is pointed out. Author.

See also Abstract 927.

LATITUDE AND LONGITUDE.

1032. Precise astronomic positions on a provincial boundary. N. J. Ogilvie. *Roy. Astron. Soc. Canada, J.*, **34**, *pp.* 1–14, *Jan.*, 1940.—The demarcation of the northerly part of the inter-provincial meridian boundary between Saskatchewan and Alberta was carried out during 1938. A precise astronomical determination of position was needed close to the northern extremity of the meridian boundary to locate the 60th parallel of latitude, the legal boundary. Details are given of the method used and the results obtained in fixing the astronomic and approximate values of the latitudes and longitudes of the four precise astronomical stations established on the boundary line. R. S. R.

See also Abstract 1056.

NEBULÆ.

1033. Rotation of Andromeda nebula. H. W. Babcock. *Lick Observat., Bull. No.* 498, *pp.* 41–51, *rec. Feb.*, 1940.—Spectrographic observations of the rotation of M 31 have been made with the nebular spectrographs at Lick and Mt. Wilson. Radial velocities were observed in the solar-type spectrum of the unresolved nucleus, out to 15′ on either side, and in the emission spectra of the outlying gaseous nebulæ in the spiral arms. The core has a period of rotation of about $1{\cdot}1 \times 10^7$ yr. The angular velocity of the outer regions is nearly constant beyond about 20′ from the nucleus, and corresponds to a period of $9{\cdot}2 \times 10^7$ yr. The obvious suggestion is that a great proportion of the mass must lie in the outer portions, and the author calculates the mass distribution on various plausible assumptions. The total mass out to a diameter of 3°·2 is of the order of 10^{11} suns, which is about half that attributed to our own galaxy. The latter, however, is of twice the extent, and its outer stars are believed to partake of a " planetary " type of rotation rather than the " solid " form observed in M 31. A. Hu.

1034. Emission nebulæ in Messier 101. C. K. Seyfert. *Astrophys. J.*, **91**, *pp.* 261–263, *March*, 1940.—Ten emission objects in the spiral nebula M 101 have been found on slitless spectrograms taken with the 82-inch telescope of the McDonald Observatory. Attention is directed to one of these emission objects in particular, a small group of stars which appears to have an emission spectrum of an unusually high degree of excitation. Author.

See also Abstracts 1046, 1047, 1048.

PLANETS.

1035. Spectrophotometric study of 3 asteroids. W. A. Johnson. *Harvard Coll. Obs., Bull. No.* 911, *pp.* 13–16, *Aug.* 1, 1939.—Three asteroids have been spectrophotometrically compared with four G0 stars. The limited data indicate a considerable range in spectral reflectivity. The colour of Vesta, and possibly that of Thetis, may vary with the light variation. The results show the need for accurate spectrophotometric data yielding information on asteroidal physical characteristics, and point out the equally imperative need for accurate magnitudes obtained simultaneously in two or three colours, in order to permit detection of changes in the spectral reflectivity of asteroids in the course of their axial rotation. Author.

STARS.

1036. Absolute colour indices of stars. P. Rossier. *Arch. des Sciences*, **21**, *pp.* 270–303, *Sept.–Oct., and pp.* 307–318, *Nov.–Dec.*, 1939.—The author compares the various scales of absolute colour indices by which visual stellar magnitudes may be converted to bolometric values. Numerical integration from an assumed spectral sensitivity function of the eye, using an assumed distribution of energy in the stellar spectrum considered, is a long process, and comparisons with graphical methods using a sensitivity curve for the eye, show that these, though less precise, are quicker and of sufficient accuracy. Corrections for hot stars from Wien's law to Planck's are given for various acuities. The colour-index scales of Eddington, Bottlinger, Hertzsprung and Blecksley are discussed and intercompared. The inverse method of attack, viz. given a colour-index scale,

derive the sensitivity constants of the eye, leads to a table in which all previously-published scales are used to calculate, either by Wien's or Planck's formula, the wavelength of maximum sensitivity of the eye. The values so found compare well with direct psycho-physiological measurements. Residual differences are possibly due to the different behaviour of the eye to the faint point-sources encountered in astronomy and to the brighter extended sources used in the laboratory. A. Hu.

1037. Colour indices of early-type stars from Harvard mimeograms. M. R. Hunt, F. S. Patterson and E. A. Raymond. *Harvard Coll. Obs., Bull. No.* 911, *pp.* 17–23, *Aug.* 1, 1939.—Colour indices of 1 300 B2 to A5 stars within 20° of the galactic plane, and of 560 stars with $\beta \geq 30°$, have been analysed for evidence of selective absorption. There is evidence in the magnitudes used either of a scale error or of systematic errors in spectral classification amounting to $0^m{\cdot}05$ per magnitude. This conclusion is corroborated by the colours of the G0 stars with $\beta \geq 30°$. In regions of galactic longitude 0° to 30°, 70° to 115°, 150° to 180°, are found respectively, a selective absorption of $0^m{\cdot}46$, $0^m{\cdot}31$, and $0^m{\cdot}55$ per kiloparsec. The scatter in the colour indices is clearly shown in the figures; the exact numerical values derived should not, therefore, be accepted too literally. They indicate, however, a selective absorption of the same order of magnitude as that found by other investigators. Authors.

1038. Dependence of errors in absolute magnitudes on trigonometric parallaxes. D. Hoffleit. *Harvard Coll. Obs., Bull., No.* 911, *pp.* 24–28, *Aug.* 1, 1939.—Systematic differences, dependent on the sizes of the trigonometric parallaxes, have been found between the spectroscopic and the trigonometric absolute magnitudes of bright stars. Various possible sources of these discrepancies are discussed and it is found that the difference between the observed and the true frequency-distribution of the trigonometric parallaxes will account for the average differences of $M_{sp} - M_t$ found for all the spectral classes taken together. If the number of stars were sufficiently large for the determination of the Eddington-Dyson corrections for each spectral class separately, the dispersion of the values $M_{sp} - M_t$ could be decreased. Author.

1039. Spectroscopic determination of stellar rotation. A. Colacevich. *Accad. Lincei, Atti,* **29,** *pp.* 585–589, *June* 2, 1939.—A criticism by W. Krat of the author's approximate method for determining stellar rotation from the distortion of the intensity profile of spectrum lines, is refuted. The method is confirmed by calculations for two He lines of 44 ι Ori for which values by the exact method of Carroll and Ingram are available. A new method proposed by Krat is shown to be unsound. W. S. S.

1040. Continuous absorption of light by negative H-ions. H. S. W. Massey and D. R. Bates. *Astrophys. J.*, **91,** *pp.* 202–214, *March,* 1940.—In view of the possible importance of H ions in absorbing long-wave-length radiation in stellar atmospheres, it is desirable that a reliable theory of the continuous absorption by such ions be available. Such a theory is provided in this paper, and the resulting calculated values of the absorption coefficient in the wavelength region of astrophysical importance are shown to be accurate. This is made possible, on the one hand, by the existence of the accurate wave function for the ground state of H^- due to Hylleraas and, on the other, to a detailed analysis of the factors determining the form of the continuous wave function representing the state of the system in which one electron is ejected. The effects of distortion of the wave representing this electron by the static and polarized atomic field, of electron

exchange, and of the non-separability of the wave function are all considered in detail and are found, for the particular case of H^-, to be incapable of affecting the calculated values. AUTHORS.

1041. Metastability of H and He levels. G. BREIT AND E. TELLER. *Astrophys. J.*, **91,** *pp.* 215–238, *March,* 1940.—The mean life of the 2s state of H in the absence of collisions is primarily determined by the simultaneous emission of two photons. Owing to this cause the mean life is $\sim 1/7$ sec. It is expected that the mean life of 1s 2s ^{1}S of HeI is of the same order of magnitude and is much shorter than that of 1s 2s ^{3}S of HeI. The non-adiabatic collisions with electrons are found to be more important than the static effects at small electron densities, leading to a transition probability $\sim 1/600$ sec.$^{-1}$ for an electron temperature $\sim 10\,000$°C. and an electron density 30 cm^{-3}. The effect of static electric fields on the 2s state of H is worked out in more detail than previously by taking into account the hyperfine structure. The mean life in static electric fields which are strong enough to make double emission of little importance and yet weak enough to give a mean life $> 10^{-7}$ sec. is found to be the sum of two lives: (1) the mean life calculated neglecting hyperfine structure and (2) the mean life calculated neglecting radiation coupling. In both (1) and (2) the mixing of 2p into 2s by the Stark effect is taken into account. Radiations due to quadrupole and magnetic dipole effects are considered qualitatively for 1s 2s ^{3}S of He and quantitatively for 2s of H. For the latter there exists a small radiative magnetic dipole effect on Dirac's theory of the electron which is absent in the ordinary spin model. AUTHORS.

1042. Physics of stellar interiors and stellar evolution. H. A. BETHE AND R. E. MARSHAK. *Phys. Soc., Reports,* **6,** *pp.* 1–15, 1939.

1043. Minimum theorem concerning internal constitution of stars. W. GLEISSBERG. *Observatory,* **63,** *pp.* 15–17, *Jan.,* 1940.—The theorem already given [see Abstract 2772 (1938)] can be interpreted as follows:—In the internal constitution of stars the condition of mechanical equilibrium can be replaced by the condition that the sum of the mass and mass excess within radius r, when integrated as a function of the total pressure from centre to boundary shall attain its minimum. The condition of radiative equilibrium is also replaceable by the condition that the sum of the mass and mass excess, integrated as a function of radiative pressure from centre to boundary, shall attain its minimum. The minima concerned refer to comparison with neighbouring configurations. G. C. McV.

1044. Evolution of stars. R. A. LYTTLETON AND F. HOYLE. *Observatory,* **63,** *pp.* 39–43, *Feb.,* 1940.—The authors disagree with the view that from the mode of energy generation in a star and its chemical composition it is necessary only to calculate the change with time of its constitution arising as a result of subatomic processes in order to determine its evolutionary path. The problem cannot be solved without reference to the dynamical features associated with stars of particular kinds, particularly double stars; nor should the effect of radiation be emphasized to the exclusion of that of external agencies. It is asserted that dynamical evolution takes place in binary systems; and the authors suggest that a process of accretion of the cosmical cloud by the stars is quantitatively sufficient to fit the facts. Such accretion will depend on the interstellar density around and the peculiar velocity of the evolving star: giant stars of low velocity will lie in clouds of great density, whilst small, high-velocity dwarfs will be situated in tenuous regions. Radiation determines the

evolutionary path of the latter; accretion of matter as well as radiation that of the former. A. Hu.

1045. Generalized Thomas-Fermi method as applied to stars. R. E. Marshak and H. A. Bethe. *Astrophys. J.*, **91**, *pp.* 239–243, *March*, 1940.—A treatment is given of stars of intermediate density such as dense red dwarfs and subdwarfs, using the statistical method of Thomas-Fermi to calculate the free-electron density, the gas pressure, and the opacities. The Thomas-Fermi equation has been generalized to take account of the high temperature and a mixture of elements. By taking finite boundary conditions as for metals, it is then possible to integrate the star equations. Authors.

1046. Galactic and extragalactic studies. Part III. Photographs of 30 southern nebulæ and clusters. H. Shapley and J. S. Paraskevopoulos. *Nat. Acad. Sci., Proc.*, **26**, *pp.* 31–36, *Jan.*, 1940.—The authors consider the unusual forms, those chaotically irregular like the Magellanic Clouds, and those peculiar variations of the typical and spheroidal galaxy, as showing process of development. 23 photographs are given of 29 objects with comments; 4 of gaseous nebulæ, 1 trifid, 1 lagoon, 1 open cluster, 7 spirals, 3 barred spirals, 2 plate spirals, 1 double spheroidal, 1 streak nebula, 1 planetary, 2 of Magellanic type, 1 spheroidal, 1 ring-tail spiral, and 3 globular clusters. The spirals NGC 7582–90–99 (probably one physical system) are alike in dimensions, inclination and class, but differ in structural detail. NGC 55 is only exceeded in angular dimension among spirals by Andromeda and Messier 33 nebulæ; it is perhaps a double edge-on spiral without nuclei. NGC 6935 and 6937 are 4′ apart and both "face-on"; in details, almost identical. The globular cluster Centauri has its total absolute magnitude comparable to the Andromeda companion. [See Abstract 378 (1940) and following Abstract.] A. S. D. M.

1047. Galactic and extragalactic studies. Part IV. Photometry of two large southern clusters of galaxies. H. Shapley and C. D. Boyd. *Nat. Acad. Sci., Proc.*, **26**, *pp.* 41–49, *Jan.*, 1940.—In the study of nearly eight thousand galaxies on two exceptionally good 3-hr. plates, made with the Bruce refractor at the Boydon Station, two rich groups have been found and measured. They bear the same relation to the ordinary small group of galaxies as globular clusters bear to galactic clusters, but the rich groups of galaxies are not highly or isometrically centralized. The distances are 29 and 38 megaparsecs for Groups *A* and *B*, respectively, and their diameters exceed 250 kiloparsecs. The plates did not reach to the faintest objects in either system, but, when appropriate correction was made for field nebulæ, approximately four hundred cluster members were counted in Group *A* and three hundred in Group *B* and the total populations at approximately a thousand each. The corresponding space densities are probably in excess of 10^{-27} gm./cm^3. The luminosity curve deduced for Group *B* is very similar to that found for other rich systems of this sort; but in Group *A* there appears to be a considerable number of unusually bright galaxies which are almost certainly members of the system and not merely superposed field galaxies. The giant systems in Group *A* are of both the spiral and spheroidal types. Some of them are comparable with the Andromeda nebula in luminosity, and one of them, IC 78, a spiral on edge, appears to exceed the Andromeda nebula both in luminosity and in linear dimensions, if it is not by chance a nearer superposed galaxy. [See preceding and following Abstracts.] Authors.

1048. Galactic and extragalactic studies. Part V. Period frequency of classical Cepheids in the Magellanic clouds. H. SHAPLEY AND V. MCKIBBEN. *Nat. Acad. Sci., Proc.*, **26**, *pp.* 105–115, *Feb.*, 1940.—The periods and median magnitudes of 80 classical Cepheid variables in the Small Magellanic Cloud have been determined in order to supplement earlier material for an investigation of the form of the period-frequency curve and the dependence of median period on position in the star cloud. It is found that the maximum frequency at about 4·5 days for galactic Cepheids holds also in the Small and Large Clouds when a strong selection for the bright long-period Cepheids affects the material, but when the selection is eliminated the maximum of the frequency curve shifts to approximately two days, where heretofore a minimum of frequency has been supposed to occur. Between the centre and the borders of the Small Cloud the median frequency differs by two or three days, an indication that the Cepheids in the regions rich in stars are systematically brighter and more massive than in the outer parts of the Cloud. Preliminary results for the Large Magellanic Cloud are presented. An investigation of the galactic Cepheids with respect to the dependence of period on position in the Milky Way gives inconclusive results, probably because of the many vitiating factors of selection in the discovery and analysis of galactic variable stars. [See preceding Abstract.] AUTHORS.

1049. Galactic star clusters. R. J. TRUMPLER. *Astrophys. J.*, **91**, *pp.* 186–201, *March*, 1940.—The principal methods for determining intra-galactic distances greater than 500 parsecs are discussed and their application to galactic star clusters is outlined. A comparison of distance moduli derived from photometric spectroscopic data with distances based on angular diameters yields an average coefficient of photographic absorption of $0^m{\cdot}7$ per kiloparsec. Preliminary results for the radial velocities of 39 clusters lead to a value $A = +0{\cdot}015$ km./sec.·parsec for the coefficient of differential galactic rotation. The good agreement of this result with other determinations confirms the correctness of the adopted distance scale of galactic star clusters. The radial velocities also indicate a negative k term increasing in amount with distance. The appearance of galactic star clusters seen at great distances projected on the background of faint stars is studied. At distances of more than 5000 parsecs even the most favourable objects would have been missed by the surveys of the past, while the poorer and less luminous objects may have been overlooked at much smaller distances. This explains why the space distribution of the known star clusters shows little relation to the structure of our galaxy. Attention is drawn to the promise of a search for more distant clusters on photographs taken in red light with instruments of large aperture and large field. AUTHOR.

1050. Proper motions in galactic cluster M 67. E. G. EBBIGHAUSEN. *Astrophys. J.*, **91**, *pp.* 244–256, *March*, 1940.—Proper motions are derived on Yerkes plates for an area 30′ in dia. centred on the cluster M 67. The results are tabulated. Plots of the motions and the position of the cluster members in the cluster are given. The spectrum-magnitude diagram of the cluster, and the luminosity function of the cluster members are also figured. [See also Abstract 2410 (1939).] AUTHOR.

1051. Spectrum of Nova Aquilæ (1918). A. B. WYSE. *Lick Observat., Publ.*, **14**, 3, *pp.* 93–215, *rec.*, 1939.—This paper presents a comprehensive description of the spectral development of Nova Aquilæ in 1918 and subsequently as recorded on spectrograms taken at Lick Observatory supple-

mented by some other plates taken at Mt. Wilson, Capetown and Cambridge Observatories. After a description of the nature of the observational material there follow general descriptions of the absorption and emission spectra for the year 1918 and an account of the nebular envelope and spectrum from 1919 to 1937. In the last 70 pages is given a day-to-day journal of observations of the spectra for the period June 8th to Aug. 13th, 1918, in which it is endeavoured to record the complicated detailed changes as briefly and simply as possible without omitting any details which seem likely to be significant. Numerous spectra are reproduced in the 4 pages of plates. J. E. K.

1052. Types of novæ. F. Zwicky. *Rev. Modern Physics*, **12**, *pp.* 66–85, *Jan.*, 1940.—A general classification of novæ in terms of integral parameters is proposed. It is shown that the distribution of novæ in dependence on the intrinsic luminosity at maximum brightness reveals the existence of two distinct classes, common novæ and supernovæ. A tentative classification of novæ in terms of integral parameters and a brief tabulation of observational data on these parameters are given, with a discussion of problems arising therefrom. The frequency of occurrence of novæ in dependence on their absolute magnitude is explicitly established and graphically represented. The importance is analysed of the fact that supernovæ preferably appear in those parts of nebulæ whose surface brightness is low, and two outstanding cases are reproduced. It is shown that the average frequency of occurrence of supernovæ in different types of nebulæ does not depend essentially on the type. Reasons are advanced against the assumption of collisions between luminous stars as a cause for supernovæ. Finally, the decisive observations and considerations which have resulted in the recognition of supernovæ as a separate class of temporary stars are reviewed. N. M. B.

1053. Coefficient of limb darkening for YZ(21) Cassiopeiae. G. E. Kron. *Lick Observat., Bull. No.* 499, *pp.* 59–71, *rec. Feb.*, 1940.—A new light-curve of the eclipsing variable YZ Cassiopeiae has been obtained with a photoelectric photometer [see Abstract 1028 (1940)]. The various elements derived from the observations are discussed at length. A. H.

1054. Report on astronomy. B. J. Bok. *Popular Astron.*, **47**, [28 *pp.*], *Aug.*, 1939.

See also Abstract 1189.

SUN.

1055. Recent unusual solar activity. M. Salaruddin and B. G. Narayan. *Observatory*, **63**, *pp.* 8–10, *Jan.*, 1940.—Details of the solar activity observed at Kodaikanal during the 3 weeks commencing Aug. 26, 1939, are given. The spots and eruptions referred to were in latitude 15°S. and Doppler effects of 1 and 2 Å were observed in the eruptive areas. Metallic prominences were observed as well as the breaking up of dark H markings. No unusual magnetic disturbances of the earth's field were, however, recorded at Abinger in England but a wireless fade-out on easterly channels corresponded to maximum eruptive activity on one occasion during this period. G. C. McV.

See also Abstracts 1068, 1324.

GEOPHYSICS.

GEODESY.

1056. Cosmic terrestrial relationships. *Roy. Astron. Soc. Canada, J.*, **33,** *pp.* 415–430, *Dec.*, 1939.—In this report to the American Geophysical Union the functions of the several committees for coordinating interests in geophysics are explained. That dealing with cosmic terrestrial relationships provides a summary, from the point of view of the structural geologist, of the evidence that the earth itself affords regarding crustal movements. Geological evidence for crustal movements is reviewed first and next astronomical evidence for variation in geographical coordinates. The investigations of variations in longitude which have been completed are discussed and the lines projected for further research are outlined.

R. S. R.

GEOPHYSICS, APPLIED.

See Abstract 1064 and

459B. Geophysical measurements. Resistance methods. V. Fritsch.

HYDROSPHERE, PHYSICS OF THE.

1057. Horizontal oscillations of bay water induced by tidal currents. K. Hidaka. *Imp. Marine Obs., Kobe., Japan, Mem.*, **7,** 1, *pp.* 1–14, *July*, 1939.—Oscillations in a small land-locked bay due to tidal currents are mathematically treated. [See also Abstract 1565 (1939).] W. A. R.

1058. Free oscillation of water in an oval basin. K. Hidaka. *Imp. Marine Obs., Kobe, Japan, Mem.*, **7,** 1, *pp.* 15–19, *July*, 1939.—Tuboi's method is applied to an oval basin of symmetrical shape, for which numerical calculations are given. [See also Abstract 1566 (1939).]

W. A. R.

1059. Wind circulation of water and inertia terms. K. Hidaka. *Imp. Marine Obs., Kobe, Japan, Mem.*, **7,** 1, *pp.* 21–39, *July*, 1939.—Hydrodynamical equations were integrated on the assumption that a stationary wind exerts a constant tangential stress on the surface, and with boundary conditions such that the components of velocity across sides, walls and bottom were zero. The inertia terms of the hydrodynamical equations were taken into account, for these terms proved not to be negligible in the case of wind currents. The water surface rises leewards and falls windwards. Wolf's method of integration was used. The numerical calculations proved to be extremely laborious. W. A. R.

1060. Transport of rolled solid materials. C. Jaeger. *Comptes Rendus*, **210,** *pp.* 208–210, *Feb.* 5, 1940.—Empirical formulae given by various authors for limiting discharge, entraining force and velocity relating to the transport of rolled materials over the mobile bed of a stream of water are critically examined. Froude's generalized law of similitude is found to hold in the case of the transport of matter which is not too fine and which is rolled along in turbulent motion. J. S. G. T.

1061. Equilibrium of grains on bed of stream. C. M. White. *Roy. Soc., Proc. A*, **174,** *pp.* 322–338, *Feb.* 21, 1940.—A fluid flowing over a loose flat granular bed tends to move the grains forward, and the conditions under which movement of the grains begins depend not only upon the speed but also on the nature of the motion in the stream; viscous steady motion, steady inviscid motion and turbulent motion act somewhat

differently and the speed necessary to dislodge grains differs appreciably in the three cases. The phenomena are studied experimentally in the case of a lubricating oil or water flowing over a sand bed. At high speeds wall turbulence reduces the mean apparent starting stress by 40% or more. The results are not directly applicable to the case of rivers. J. S. G. T.

1062. Echo-sounding in bathymetric surveys of lakes. C. H. Mortimer and E. B. Worthington. *Nature*, 145, *pp.* 212–214, *Feb.* 10,1940.—Using the British Admiralty pattern magnetostriction echo-depth recorder, the authors have recorded the contours of the bottom of a number of lakes in the English Lake District. The records reveal not only the mud bottom, where such mud exists, but also the underlying glacial clay and rock beneath. The investigations of this character, commenced in Lake Windermere were followed up by (*a*) making observations on the nature of the various layers forming the lake bed and (*b*) carrying out surveys with the echo sounder on 14 other of the larger lakes in the district. In the survey of Windermere 200 cross-sections representing 150 miles of continous sounding were recorded in 5 weeks. In Esthwaite Water one of the records reveals a mound of hard rock projecting through an even layer of soft deposit, the thickness of the latter being roughly uniform and following the irregularities of the hard floor below. It is anticipated that the recorded stratification of the lake bed deposits will throw light on the post-glacial history of the lake basin. A. B. W.

LAND, PHYSICS OF THE.

1063. Temperature, melt water movement, and density increase in the névé of an Alpine glacier. T. P. Hughes and G. Seligman. *Roy. Astron. Soc., M.N., Geophys. Supplement*, **4**, *pp.* 616–647, *Dec.*, 1939.—The temperatures in the névé region of the Aletsch Glacier have been measured to a depth of 30 m. and the position of the winter "cold wave" established. During early summer the névé temperatures rose to zero, and the rate at which heat entered was much greater than was possible by thermal conduction alone. It was concluded that the heat was carried into the firn by melt water from the surface, which became frozen out when temperatures below zero were encountered. A temperature distribution in the firn at the end of winter was calculated from the equation of thermal conduction and gave close agreement with observed values. The absence of temperature gradient, apart from seasonal fluctuations, in the névé region of the Aletsch Glacier was discussed and the reason provided. Measurements of the quantity of melt water flowing downwards in the firn have been obtained. The rate near the surface depends on meteorological conditions. The character of the flow is discussed. Density changes in the firn to a depth of 30 m. have been followed. Freezing of the melt water in the firn plays an important part in increasing its density but the settling process was mainly responsible for consolidating the firn in Alpine glaciers. R. S. R.

1064. Isodielectric lines and geologic structure. H. Löwy. *Phil. Mag.*, **29**, *pp.* 32–35, *Jan.*, 1940.—Basing his remarks on the theory of Terzaghi that the settlement s of a clay layer of the initial thickness h = the height of the column of pure water pressed out per unit of surface, and pointing out that clay with water in its pores is electrically considered a metallic suspension (conducting particles of water dispersed in insulating clay) the author applies his former equations [see Abstract 5044 (1938)] and on designating by ϵ the dielectric constant of the mixture and by ϵ_c the

dielectric constant of the clay and putting $(\epsilon - 1)/(\epsilon + 2) = [\epsilon]$ the following conclusions are reached: (1) If $\epsilon > \epsilon_c$ there must be water in the rock or ore; (2) if $\epsilon < \epsilon_c$ there must be pores or fissures in the rock. In the second paper the subject is further developed and the infiltration depth of rain and the water content of rocks are dealt with. Diagrams are given from observations in the western desert of Egypt. J. J. S.

1065. Radioactivity of rocks. E. Rothé and A. Hée. *Comptes Rendus*, **210**, *pp.* 30–32, *Jan.* 3, 1940.—The radioactivity of varying thicknesses of the finely powdered rock is determined, and plotted against thickness. The curve so obtained is compared with similar curves obtained with similar powders of (1) a neutral salt containing $3{\cdot}77 \times 10^{-5}$ gm. $Th(NO_3)_4$ and (2) $BaCl_2$ containing $52{\cdot}2 \times 10^{-12}$ gm./gm. $RaCl_2$. The curve given by (1) is approximately a straight line, that by (2) ends with a horizontal portion, indicating that above a certain thickness the radioactivity depends only on the surface portion of the sample. The curves obtained with the rock when compared with these standard curves show the approximate amounts of Th and Ra present. C. A. S.

See also Abstracts 973, 1056.

METEOROLOGY.

1066. Ozone measurements over Mt. Evans, Colo. R. Stair and I. F. Hand. *Monthly Weather Rev.*, **67**, *pp.* 331–338, *Sept.*, 1939.—The measurements were taken in the latter part of July 1936 and 1938 by means of 4 Ti photocells together with filters. Details are given of the method of accurate determination of the spectral response of the cells and of the transmissions of the filters. The amount of ozone in the stratosphere was found to be 0·20 cm. at normal temperature and pressure when two of the cells were used and 0·22 cm. when the other two were employed. Whenever definite changes in ozone amount were observed, they were found to be accompanied by change of origin in the air masses above the station. The solar energy curve outside the atmosphere was also deduced from the observations. Between 3 100 and 3 500 Å the curve agrees with those of Petit (1931) and Coblentz and Stair (1935). Below 3 100 Å the curve gives higher energy values in the form of a maximum at about 3 000 Å. G. C. McV.

1067. Interaction between polar front and tropopause. B. Haurwitz. *Roy. Soc. Canada, Trans., Sect. III*, **33**, *pp.* 83–105, *May*, 1939.—As wave motion at the polar front causes the tropopause to oscillate, so wave motion at the tropopause affects the polar front surface. The observed relations between motion, temperature and pressure variations are interpreted by the author as relations between wave motions in a fluid with an internal surface of discontinuity. Two types of wave are present in such a system (1) the " external " waves, with amplitude greatest at the free upper surface and motion in the same direction in both layers, and (2) " internal " with amplitude greatest at the internal surface of discontinuity and motion opposite in the two layers. The expression for the wave velocity is found to consist of two terms. The first, or convective term, depends on the mean velocities in both layers; the second, or dynamic term, on the forces acting on the system. Consequently, the region of stability is larger for tropopause waves than for those at the polar front, and so polar front waves are more likely to arise spontaneously. This being so it follows that tropopause waves will frequently be due to the former. As however, actual motion in the atmosphere may arise from the

superposition of internal and external waves, the author points out that the observed relations may be more complicated than those arrived at in the paper. A. E. M. G.

1068. Weather changes from day to day. H. Arctowski. *Monthly Weather Rev.*, **67**, *pp.* 322–330, *Sept.*, 1939.—Direct observations, particularly in high latitudes, has revealed the presence of waves of pressure with period and amplitude depending to some extent on the latitude The extent of a wave is shown by connected areas of increase and decrease of pressure on a chart of isallobars. For areas of positive pressure difference the author suggests the name of anoterons, and katoterons for those of pressure decrease. The pressure wave he terms baroteron. He then considers the movements of these for definite periods and over definite regions, as for example, over America, Dec. 1935. Comparison is made with weather maps for the same period. The question is then raised as to whether lows and highs are due to the crossing of katoterons and anoterons. Likewise an examination of these waves over Europe and Asia as they occurred on Jan. 7, 1910, along with the rainfall distribution supports the hypothesis of correlation between these quantities. The paper is illustrated by a large number of charts. A. E. M. G.

1069. Law of disturbance. S. Fujiwhara. *Imp. Acad. Tokyo, Proc.*, **15**, *pp.* 292–297, *Nov.*, 1939.—The author discusses in a general way the conditions of instability and lability and their application to the formation of convectional cloud. Examples are shown of aerograms typical of heat and frontal thunderstorms and that preceding an intense typhoon. He lays down as a general law that for a given rate of supply of energy, the higher the degree of instability the smaller the scale of the disturbance (depression, cyclone, typhoon, squall, thunderstorm) and the more frequent its appearance. R. S. R.

1070. Sea-salt nuclei. H. L. Wright. *Roy. Meteorolog. Soc., J.*, **66**, *pp.* 3–12, *Jan.*, 1940.—A review is given of published data relating to the number of sea-salt nuclei and the mass of sea-salt dissolved in the nucleus. The origin, composition and behaviour of the sea-salt nuclei in the liquid and solid form, and their range of concentration in the air over the oceans, are examined. The mass of sea-salt in the nucleus is considered from deposits of rime, rain water, fog and cloud in many areas. Measurements regarding the Cl_2 content in the air, and the size distribution in sea-salt nuclei are examined and the various results are tabulated. Finally Melander's hypothesis of the formation of nuclei is examined. R. S. R.

1071. Height of nacreous clouds. C. Störmer. *Comptes Rendus*, **210**, *pp.* 179–181, *Jan.* 29, 1940.—The author extends a preliminary note regarding these nacreous (mother of pearl) clouds [see Abstract 3442 (1933)]. From the large numbers of photographic records of them now available, their heights have been determined and are found to range from about 23 km. to nearly 28 km. These results are presented diagrammatically and are also given in tabular form. Observation shows that generally they are moving rapidly, and with an easterly component. There is also some evidence of turbulence, while a lunar corona indicates droplets of diameter about 0·002 5 mm. Meteorological conditions existing at the time of their observations were similar to those noted by Mohn on observing the same type of cloud towards the end of the last century. A. E. M. G.

1072. Absorption of light by the atmosphere. Part III. A. Vassy and E. Vassy. *J. de Physique et le Radium*, **10**, *pp.* 459–464, *Nov.*, 1939.

—After subtracting from the total atmospheric absorption, the true absorption of the gases constituting the atmosphere and the absorption due to molecular diffusion, the residual absorption is due to aerosols and is composed of two different types, one neutral and the other selective. The latter may have two entirely different natures, which at times co-exist. From a consideration of theory and of experimental observations, an attempt has been made to establish the origin of these different types of absorption. [See Abstract 4265 (1939.)] W. R. A.

1073. Atmospheric opacity at Valentia. H. L. Wright. *Roy. Meteorolog. Soc., J.*, **66**, *pp.* 66–76, *Jan.*, 1940.—In the present paper the author tests from the results of direct observations, certain relations established theoretically in a previous investigation [see Abstract 3218 (1939)] between atmospheric visibility, opacity, humidity and wind direction. As regards opacity and humidity he finds that in a smoke-free atmosphere the relation is much the same as indicated by theory. For humidities below 70% the opacity is practically constant, in agreement with the hypothesis that the nuclei which consist of sea-salt then become crystalline. Slight diurnal and annual variations in the opacity take place in addition to that due to humidity variation. An examination of the effect of wind direction shows that the opacity variation in air which has passed over smoke sources is entirely different from that in smoke free air. The investigation also reveals that in order to make the theoretical equations fit with the results of observations, N and Q must each have a certain value, where N is the number of sea-salt nuclei per cm^3., and 6Q the average mass of salt per nucleus. A comparison of the salt content of air so found is made with results obtained by other methods in other places. A number of tables and diagrams illustrate the paper. A. E. M. G.

1074. MacGregor Arctic expedition to Etah, Greenland, July 1, 1937, to Oct. 4, 1938. C. J. MacGregor. *Monthly Weather Rev.*, **67**, *pp.* 366–382, *Oct.*, 1939.

See also Abstracts 993, 1063, 1083, 1228.

SEISMOLOGY.

1075. P-Curve of a South American deep-focus earthquake. R. R. Heinrich. *Seismological Soc. of America, Bull.*, **29**, *pp.* 527–530, *Oct.*, 1939.—Owing to difficulties in interpreting the S-phase, the epicentre and depth of focus were determined by methods independent of all S readings. The average deviation of the data of this earthquake from the 200-km. curve of Brunner is $-1{\cdot}02$ sec. The mean deviation from the Gutenberg curve is $-4{\cdot}98$ sec. The two curves differ in slope, and exhibit the phenomena of crossing noted by Westland in his study of 400-km. curves. In the present case the crossing occurs at about $102{\cdot}3$ deg. W. A. R.

1076. Aseismic design of wooden structures. T. C. Combs. *Seismological Soc. of America, Bull.*, **29**, *pp.* 539–547, *Oct.*, 1939.—Results of tests to investigate the effect of duration of stress on the strength of timber are given. Unit working stresses for wood members can be increased as the duration of stress is decreased. Such increases involve a mechanical property of the material and can be applied without reducing the factor of safety. Increases may be applied to all unit stresses with the exception of the modulus of elasticity. The matter has important bearings on design for aircraft and for earthquake and wind loadings. W. A. R.

1077. Times of transmission for small distances and focal depths. H. Jeffreys. *Roy. Astron. Soc., M.N., Geophys. Supplement,* **4,** *pp.* 571–578, *Dec.*, 1939.—For near earthquake phases the rates of travel of Pg, P*, Sg, S* can be taken, for horizontal transmission from a previous paper [see Abstract 2813 (1939)]. The method used to obtain the table quoted for the times of transmission for a surface focus are explained and the application of the table is discussed. The results are applied to the Tauern, Schwadorf and Jersey earthquakes. P and S for small distances and focal depths are considered and a table evaluated for the times of transmission at short epicentral distances at different focal depths.

R. S. R.

1078. Theoretical travel-times of the phases PP, PPP, PS, PPS, SS, PSS, and SSS. K. E. Bullen. *Roy. Astron. Soc., M.N., Geophys. Supplement,* **4,** *pp.* 588–593, *Dec.*, 1939.—Jeffreys revised tables for the P and S travel-time [see Abstract 2813 (1939)] have been used to calculate theoretical travel-times for phases which have undergone reflection at the earth's outer surface, assuming in all cases that each reflection is a true surface reflection. The method of matching gradients was used, special care being taken, when necessary, in dealing with the direct and refracted rays associated with the sharp changes of $dT/d\triangle$ for component paths near 20°. Sufficient data have been provided in the tables to enable the rapid estimation of any particular travel-time within an error not exceeding about 1 sec. R. S. R.

1079. Times of core waves. (Second paper). H. Jeffreys. *Roy. Astron. Soc., M.N., Geophys. Supplement,* **4,** *pp.* 594–615, *Dec.*, 1939.—Tables have been constructed connecting $\triangle$ and t for the following series of curves I, K(ABE), KIK = K(DF), PKP, PKS, SKS, PKKP, PKKS, SKKS, SKKS(DF), SKKKS(ABC), PcPPKP, PcSPKP, ScSPKP, ScSP, SKSP, PKPPKP, and PKPPKS. The method used in obtaining these results is explained and features of these curves are discussed. [See also Abstract 2815 (1939).] R. S. R.

1080. Earthquake in Turkey. E. Tillotson. *Nature,* **145,** *pp.* 13–15, *Jan.* 6, 1940.—At 23 hr. 57 min. G.M.T. on Dec. 26, 1939, the first shock lasting 20 sec., of a violent earthquake occurred with epicentre at Erzinjan, at approximately 40° N., 38° 5′ E. This was followed at short intervals by 6 other severe shocks, the epicentres of which were first to E. and W. of Erzinjan and then to the south. There were numerous and often severe aftershocks. The intensity in the central area—approximately 100 m. in dia., was 12 on the Mercalli (1931) scale, and the maximum focal depth about 16 miles. Throughout this area destruction was practically complete and some 40 000 people are estimated to have perished; large fissures were formed and rivers changed their courses. The shock appears to have been felt instrumentally throughout the world, and several more or less antipodal shocks were reported within a few hours of the main shock. C. A. S.

TERRESTRIAL ELECTRICITY AND MAGNETISM.

1081. Ionosphere at Calcutta. J. N. Bhar. *Indian Journ. Phys.*, **13,** *pp.* 253–276, *Aug.*, 1939.—In the present paper the results of systematic ionospheric observations carried out at Calcutta (22° 33′ N) during the period Jan. 1936 to April 1937, are described. The diurnal and seasonal variations of critical frequency for the E- and F-regions of the ionosphere are presented graphically and are discussed with reference to variations expected from the u.v. light theory. It is found that the observed varia-

tions of E_1-region ionization are in general agreement with the theory of Chapman particularly during winter months. During summer months, however, there are deviations due presumably to the frequent occurrence of abnormal ionization associated with thunderstorms. The observed results are utilized for estimating the coefficient of recombination in the E-region which is found to be of the order of 10^{-9} cm^3./sec. The phenomenon of abnormal E-region ionization is discussed in detail and its association with the incidence of thunderstorms investigated. The observed variations of F_2-region ionization show that the time of diurnal maximum shifts towards the afternoon in summer. There are two distinct maxima in the seasonal variation curves for the midday and the 1600 hours ionization. These seem to coalesce in the case of the 1900 hours seasonal ionization curve. The extreme day-to-day variability of the midnight ionization makes it difficult to form any idea as to the nature of its seasonal variation. AUTHOR.

1082. Origin and distribution of thunderstorm electricity. W. J. HUMPHREYS. *Monthly Weather Rev.*, **67**, *p.* 321, *Sept.*, 1939.—Reference is first made to Simpson's theory of the origin of thunderstorm electricity and the assigned distribution of electricity within a cumulonimbus cloud. According to this distribution, the base of the cloud should have a positive charge, whereas observation finds the positive charge in the upper portion with the base negatively charged. The author considers, however, that the inferred distribution is erroneous. He points out that the level within the cloud where maximum velocity of ascent occurs is well above half-way between base and summit. From this he is able to explain how on the rupture theory the positive charge may be expected at the top and the negative at the base, thus removing the most serious objection to Simpson's theory. A. E. M. G.

1083. Meteorological phenomena and the terrestrial electric field. G. ALIVERTI AND G. LOVERA. *Accad. Sci. Torino, Atti*, **74**, *Disp.* 5a, *pp.* 573–590, *July–Oct.*, 1939.—The authors investigate the formation of ions by the action of gales on the surface of the oceans. They have verified experimentally that an air current travelling at a certain speed through sea-water produces a number of positive and negative ions. A quantitative study of the number and size of charged particles produced by cyclones proves that this phenomenon is of some importance for the ionization and electric charge of those parts of the atmosphere immediately above the sea and may even be of importance for the conservation of the negative electric charge of the earth as there is an excess of positive charges over negative charges in the foam of the waves which is borne upwards in the air current. L. K.

1084. Daily variation of atmospheric electric field in Rome. E. MEDI. *Ricerca Scientifica*, **10**, *pp.* 1005–1009, *Nov.*, 1939.—The variation of the atmospheric electric field in Rome was recorded continuously during one year. Two groups of daily fluctuations were observed. One, consisting of 2 maxima and 2 minima, is strongly dependent on the season (the maxima and minima being much more pronounced in summer than in winter); the main features of the other group consisting of 2 minima with 1 maximum in between were found to be unchanged all through the year. L. E. F.

1085. Three-hour-range index measuring geomagnetic activity. J. BARTELS, N. H. HECK AND H. F. JOHNSTON. *Terr. Mag.*, **44**, *pp.* 411–454, *Dec.*, 1939.—A 3-hour-range index K based on the "Potsdamer erdmagnetische Kennziffer" was provisionally adopted at the Washington Conference by the International Association of Terrestrial Magnetism and

Electricity in Sept., 1939. Each collaborating observatory is to assign, to each 3-hour interval beginning at 0^h, 3^h . . . etc. G.M.T. one of the integers 0 to 9 as range-index K ; their average K_m, carried to half-units expresses the new measure. Scales for K are determined by assimilation of frequency curves so that each observatory, within a year, for instance, has approximately the same number of intervals with K = 0, or K = 1, etc. The principles and practice of scaling K are described. The magnetic variations are regarded as superpositions of K-variations (to be measured) and of non-K-variations (such as regular daily variations on quiet days, to be eliminated) ; this is illustrated by typical cases. For Jan. to June, 1938, tables for K and K_m are given based on 8 observatories. From K_m daily indices B for 24-hour intervals and equivalent ranges A are derived. High correlations are found between K at the different observatories and K_m. The effect of the persistence-tendencies on these and other correlations is studied and provides examples of general interest in statistics. In general the correlation coefficient r increases with the length of the time-unit used. For the daily index B and the international character figure C, r is 0·95 for single days, but it reaches 0·98 for 4-day averages. A geomagnetic solar-flare effect was found preceding the outbreak of the intense storm on Jan. 16, 1938 ; the time interval suggests 22 hr. as an upper limit for the travel-time of the solar corpuscles which are supposed to cause geomagnetic activity. R. S. R.

1086. Origin of terrestrial magnetism. A. Dauvillier. *Comptes Rendus*, **210**, *pp.* 177–179, *Jan.* 29, 1940.—By the partial reduction by the then atmosphere of H_2 of the Fe_2O_3 of the basalts coming to the surface in connection with the formation of the ocean deeps [see Abstract 4423 (1938)] magnetite was formed, which on cooling past the Curie point (560°) was magnetized by the then existing cosmic field, and in the direction thereof. In addition to this " fossil field," to which the greater and constant part of terrestrial magnetism is due, a small and variable portion results from the rotation of the globe in a field of which the lines of force are sensibly normal to the plane of the ecliptic, and the intensity of which depends on the solar activity. The theory is elaborated in some detail, and figures given showing the results to be of the right order of magnitude. C. A. S.

1087. α-γ transformation of iron at high pressures, and problem of earth's magnetism. F. Birch. *Am. J. Sci.*, **238**, *pp.* 192–211, *March*, 1940.—The change with pressure of the temperature of the α-γ or A_3 transformation in high-purity iron has been directly determined by a dilatometric method to over 4 000 kg./cm^2., in N_2 and in A. The mean value for several different irons for the rate of change of temperature with pressure, above 1 000 kg./cm^2., is − 8·5 deg. C./1 000 kg./cm^2. ; at lower pressures, some curvature is found with A as the pressure medium, which can be accounted for in terms of the small N_2 content of the A. The latent heat is found from this rate and the change of volume to be about 4 cal./gm. It is shown that α-iron can be of limited importance in connection with the problem of the earth's magnetism, since its existence is restricted to a thin shell near the surface. The relation of Fe-Ni alloys to this question is discussed. Author.

See also Abstract 1074.

RADIOACTIVITY.

1088. Chemical activation by isomeric radioactive transition; reaction of Br^{80} (18 min. half-life) with CCl_4. J. E. Willard. *Am. Chem. Soc., J.*, **62**, *pp.* 256–261, *Feb.*, 1940.—It has been found that the radioactive transition from Br^{80} (4·4 hr.) to Br^{80} (18 min.) activates bromine in such a way as to enable it to react with CCl_4. Decay and growth curves of the activities involved give consistent proof of the existence of the reaction. Experiments over a wide temperature range show the reaction to be independent of temperature and to have an efficiency about one-third as great in the solid phase as in the liquid phase. The evidence indicates that only those Br^{80} (18 min.) atoms react which are produced as the result of the emission of a conversion electron. In the light of new data, the recoil energies previously thought to account for chemical activation by the isomeric radioactive transition of bromine are found to be too small to do so.

Author.

1089. Emission of slow neutrons by Be bombarded with α-particles. M. Benini. *Accad. Lincei, Atti*, **29**, *pp.* 590–596, *June* 2, 1939.—Part I reviews the evidence for Bohr's hypothesis on the mode of origin of the slow neutrons (energy of the order of 10^5 eV) emitted by Be bombarded with α-particles. The Be atom is assumed first to absorb and re-emit the α-particle and then to split into 2 α-particles and a neutron. This view is shown to be well supported by experimental facts. In Part II is described an experiment for determining the energy of the neutrons emitted in the process, by applying the coincidence counter to the recoil protons. A value of the order of 10^5 eV was obtained, confirming the presence of slow neutrons in the emission from the source Po + Be. W. S. S.

1090. Neutrons from U. H. Bradt. *Helv. Phys. Acta*, **12**, 7, *pp.* 553–558, 1939. *In German.*—In determining the mean number of secondary neutrons liberated from U on bombardment by fast neutrons, the author retards the liberated neutrons to thermal velocities by surrounding the source with a large tank of water. Metallic In foil was used as a neutron detector with appropriate amplifying and counting apparatus. It was found that the activity in the foil was directly proportional to the density of the thermal neutrons at the position of the detector. When a correction was applied for the effect of fast neutrons, the number of secondary neutrons per primary neutron was found to be $2{\cdot}9_5 \pm 0{\cdot}5$. The absorption of neutrons by capture in U was neglected. G. O. B.

1091. Nuclear disintegration products of U bombarded with neutrons. W. Jentschke and F. Prankl. *Phys. Zeits.*, **40**, *pp.* 706–713, *Dec.* 15, 1939.—The distribution in range and energy of the fission products of U was recorded by means of an ionization chamber. Two inhomogeneous groups were found of 60 and 90 eMV average energy, 80 and 110 eMV maximum energy respectively, corresponding to maximum ranges of about 12 and 20 mm. in air respectively. Slow neutrons gave rise to slightly more homogeneous groups than were obtained with fast neutrons. L. E. F.

1092. Comparison of radiation of radioactive isotopes formed from U and Th. I. Curie and Tsien San-Tsiang. *J. de Physique et le Radium*, **10**, *pp.* 495–496, *Dec.*, 1939.—Comparison of the β-ray spectra obtained by means of a Wilson chamber of the 3·5 hr. period radioactive elements resembling La, obtained by the bombardment with neutrons of U and Th [see Abstract 1585 (1939)] shows them to be identical within the limits of experimental error. C. A. S.

1093. Nuclear fission. L. A. Turner. *Rev. Modern Physics*, **12**, *pp.* 1–29, *Jan.*, 1940.—The first part of this paper gives a general review of results obtained to date for the period of a year since the discovery of the disruption of U nuclei by neutrons. Starting with the early experiments in 1934 following the discovery of the neutron, work on Th and the apparent transuranic elements is described, leading to the discovery of Ba as a fission product of U and the identification of the transuranic elements as isotopes of Ma, Ru, etc., The energy involved is then discussed in some detail. Sections follow giving a review of the identification of the fission products, the production of secondary neutrons and the delayed emission of neutrons after cessation of bombardment, the discovery of the instantaneous occurrence of fission, unsuccessful attempts to produce fission by photo-excitation, the determination of excitation functions and nuclear cross-sections, the theoretical aspects of the new discoveries, and the possibilities of chains of disintegration with U as a source of nuclear energy. The second part of the paper deals in more detail with special aspects of the topics mentioned above and with miscellaneous experimental results. N. M. B.

1094. Photographic method in nuclear physics. C. F. Powell. *Nature*, **145**, *pp.* 155–157, *Jan.* 27, 1940.—The energy distribution of the neutrons from the F + D reaction is examined by measurements on the recoil proton tracks in a photographic emulsion. At least 9 energy groups are found but some may be due to B contamination. Evidence is given for the possibility of measuring with reasonable accuracy the direction of the particles in the emulsion. By supporting a layer of ND_4Cl immediately above the emulsion and irradiating it with γ-rays, proton tracks are observed in the emulsion indicating the photodisintegration of the deuterium and thus suggesting a method for measuring γ-ray energies. The photographic emulsion method is also being used for work on scattering. W. E. D.

1095. Radioactive isotopes of Sc and their properties. H. Walke. *Phys. Rev.*, **57**, *pp.* 163–171, *Feb.* 1, 1940.—The results of further studies of the radioactive isotopes of Sc can be summarized as follows. (*a*) The activity of half-life 53 $\pm$ 3 min., now measured more accurately as 57 $\pm$ 2 min., produced by bombarding Ca with deuterons, which emits β-particles of energy 1·8 $\pm$ 0·1 eMV previously assigned to Sc^{41} is shown to be probably due to Sc^{49}. Sc^{49} can be produced by the decay of Ca^{49} and from Ti by bombardment with fast neutrons. It emits no γ-radiation. (*b*) Sc^{42}, half-life 13·4 $\pm$ 0·3 days, emits positrons of maximum energy 1·4 $\pm$ 0·1 eMV. (*c*) The continuous spectrum of Sc^{43} is complex, there being 2 groups of positrons and γ-radiation of energy 1·0 $\pm$ 0·1 eMV. (*d*) The 52-hr. isomer of Sc^{44} is the metastable form decaying by emitting highly internally converted γ-radiation of energy 250 ekV. (*e*) There is only one form of Sc^{46} of half-life 85 $\pm$ 1 days, emitting β-rays of energy 0·26 $\pm$ 0·01 eMV (> 95%) and 1·5 $\pm$ 0·1 eMV (< 5%) and γ-radiation of energy 1·25 $\pm$ 0·1 eMV. (*f*) Sc^{47}, half-life 63 $\pm$ 2 hr., emits β-rays of energy 1·1 $\pm$ 0·1 eMV. (*g*) Sc^{48}, half-life 44 $\pm$ 1 hr., emits β-rays of energy 0·5 $\pm$ 0·1 eMV ($\sim$ 90%) and 1·4 $\pm$ 0·1 eMV ($\sim$ 10%) and γ-radiation of energy 0·9 $\pm$ 0·1 eMV. The following previously unreported reactions have been established: $Ca^{48} + H^2 \rightarrow Sc^{49} + n^1$, $Sc^{49} \rightarrow Ti^{49} + e^-$; $Ti^{49} + n^1 \rightarrow Sc^{49} + H^1$; $K^{39} + He^4 \rightarrow Sc^{42} + n^1$, $Sc^{42} \rightarrow Ca^{42} + e^+$; $Ca^{43} + He^4 \rightarrow Sc^{46} + H^1$, $Sc^{46} \rightarrow Ti^{46} + e^-$; $Ca^{44} + He^4 \rightarrow Sc^{47} + H^1$, $Sc^{47} \rightarrow Ti^{47} + e^-$. Author.

1096. K-electron capture and internal conversion in Cr^{51}. H. Walke, F. C. Thompson and J. Holt. *Phys. Rev.*, **57**, *pp.* 171–176, *Feb.* 1, 1940.—Cr^{51} has been chemically isolated from Ti which has been bombarded with high speed α-particles and Cr which has been activated with deuterons. Its half-life is $26{\cdot}5 \pm 1{\cdot}0$ days and its identification depends on its formation in the reactions: $Ti^{48} + He^4 \rightarrow Cr^{51} + n^1$; $Cr^{50} + H^2 \rightarrow Cr^{51} + H^1$; $Cr^{50} + n^1 \rightarrow Cr^{51} + \gamma$. Cr^{51} decays mainly by K-electron capture but is probably unstable against positron emission as it emits strong γ-radiation of energy 0·5 eMV and 1·0 eMV. No positrons of energy $>$ 100 000 eV have been detected, the lower limit of the ratio K capture to emission of positrons of energy $>$ 100 000 eV being 10 000. The γ-ray of energy 1·0 eMV is due to a nuclear transition in V^{51}. It is internally converted to an extent of 0·1%, the conversion electrons having been found by absorption measurements. Electrons of energy $0{\cdot}35 \pm 0{\cdot}05$ eMV are also emitted by a strong source of Cr^{51}. It is probable that these are recoil electrons due to the 0·5-eMV γ-rays. Authors.

1097. Radioactive isotopes of Ca and their suitability as indicators in biological investigations. H. Walke, F. C. Thompson and J. Holt. *Phys. Rev.*, **57**, *pp.* 177–184, *Feb.* 1, 1940.—A further study of the induced radioactivity of Ca has been made. It has been established that the 2·5 hr. period previously assigned to Ca^{45} is in fact associated with Ca^{49}. It is shown that this isotope probably exists in 2 isomeric forms with half-lives 30 ± 1 min. and $2{\cdot}5 \pm 0{\cdot}1$ hr. The growth of Sc^{49} of half-life 57 ± 2 min. from the 2·5 hr. form of Ca^{49} has been observed. The maximum energy of the electrons emitted by Ca^{49} (2·5 hr. period) is $2{\cdot}3 \pm 0{\cdot}1$ eMV, the end point at $1{\cdot}8 \pm 0{\cdot}1$ eMV being probably due to the Sc^{49} in equilibrium with its parent. γ-rays of energy $0{\cdot}8 \pm 0{\cdot}1$ eMV are emitted by Ca^{49} (2·5 hr. period). Ca^{41} of half-life $8{\cdot}5 \pm 0{\cdot}8$ days decays by K-electron capture. A γ-ray of energy $1{\cdot}1 \pm 0{\cdot}1$ eMV is emitted and is internally converted to an extent of $\sim 10^{-3}$. Ca^{41} has been produced by the reactions: $Ca^{40} + H^2 \rightarrow Ca^{41} + H^1$; $Ca^{42} + n^1 \rightarrow Ca^{41} + 2n^1$. Ca^{45} of half-life 180 ± 10 days emits electrons of energy $0{\cdot}19 \pm 0{\cdot}01$ eMV (95%) and $0{\cdot}91 \pm 0{\cdot}03$ eMV (5%) and γ-radiation of energy $0{\cdot}71 \pm 0{\cdot}03$ eMV. Its formation has been observed in the following reactions: $Ca^{44} + H^2 \rightarrow Ca^{45} + n^1$; $Ca^{44} + n^1 \rightarrow Ca^{45} + \gamma$; $Sc^{45} + n^1 \rightarrow Ca^{45} + H^1$. The suitability of these isotopes as radioactive indicators is discussed, and it is concluded that Ca^{45} is likely to prove the only useful one. By bombarding Ca with fast neutrons, a radioactivity of half-life $4{\cdot}5 \pm 0{\cdot}5$ min. has been confirmed, but not indentified. No radioactive isotopes of K of long half-life have been extracted from Ca by activation with fast neutrons, nor has any evidence been obtained for the reaction $A^{40} + He^4 \rightarrow K^{43} + H^1$. Authors.

1098. γ-Rays from Al due to proton bombardment. G. P. Plain, R. G. Herb, C. M. Hudson and R. E. Warren. *Phys. Rev.*, **57**, *pp.* 187–193, *Feb.* 1, 1940.—A study has been made of the excitation of γ-rays from thin films of Al bombarded by protons in the energy region 0·46 to 2·6 eMV. The excitation curve exhibits a complex system of closely spaced resonances over the entire region investigated. By means of coincidence counters measurements were made of the average energy of the radiation emitted at several of the resonances. Authors.

1099. Induced radioactivity. H. J. Walke. *Phys. Soc., Reports*, **6**, *pp.* 16–47, 1939.

1100. Induced radioactivities. J. J. Livingood and G. T. Seaborg. *Rev. Modern Physics*, **12**, *pp.* 30–46, *Jan.*, 1940.—A table of the mass

numbers and relative abundance of the known stable isotopes is followed by a table of all the radioactive isotopes reported up to Dec. 1, 1939, together with a number of important features associated with them. These include degree of certainty of assignment, type of radiation, half-life, energy of radiation and method of determination, observed nuclear reactions (giving the target element, projectile, and residue) by which the radioactive isotopes are formed, and key references to the complete literature. N. M. B.

1101. Emission of Po α-particles. J. Brenet. *J. de Physique et le Radium*, **10**, *pp.* 507–512, *Dec.*, 1939.—Six additional sets of observations of intervals between the emissions of α-particles of Po were made under differing physical conditions, and the results examined by 3 different methods. All agree in pointing to a periodicity in such emissions, the period being of the order of 1 000 times the interval between two successive emissions. [See Abstract 1959 (1938)]. The result is discussed in some detail. C. A. S.

1102. Total and specific ionization of Po α-particles and their statistical fluctuations. Part II. J. M. W. Milatz and G. A. W. Rutgers. *Physica*, **7**, *pp.* 131–132, *Feb.*, 1940. *In English.*—In similar fashion [see Abstract 2830 (1939)] the straggling in the range of α-particles emitted by sources of different strengths (prepared by placing Ag foil in a solution of Po for different times) was measured. The result indicates that the strength of the source is proportional to the time of exposure of the foil in the solution, and that the straggling parameter α increases with increasing strength. By extrapolation $\alpha_0 = 0{\cdot}53$. C. A. S.

***1103. Test of counter efficiency by coincidence methods and specific ionization of β-rays of energy 50–1 000 ekV.** T. Graf. *J. de Physique et le Radium*, **10**, *pp.* 513–518, *Dec.*, 1939.—Coincidence experiments are described which involve the use of a magnetic spectrograph to determine the efficiency of Geiger-Müller counters for β-rays of energies between 50 and 1 000 ekV. The numbers of pairs of primary ions at N-T-P, found in air per cm. path are found to be 34 and 16·5 for β-rays of energies 100 ekV and 1 000 ekV respectively. In the region examined the primary ionization law could be expressed by $I = 14{\cdot}5\ \beta - 1{\cdot}42 \pm 0{\cdot}11$, where β is the ratio of the velocity of the β-particle to that of light. The experimental values were slightly lower although comparable with those to be expected form Bethe's theory. F. C. C.

1104. Diffraction spectrography of γ-rays of the Ac family. M. Frilley. *J. de Physique et le Radium*, **1**, *pp.* 34–40, *Jan.*, 1940.—The γ-spectra of Ac derivatives were examined by the turning crystal method between 20 and 750 UX. Some 40 lines were measured corresponding to nuclear γ-rays of fluorescence (K spectrum). The most intense K spectrum is that of element 86, due to AcX → An. Comparison of the γ-lines with the results obtained by analysis of the spectra of β-rays of internal conversion and of the fine structure of α-rays shows satisfactory agreement for lines of $\lambda < 175$ UX, but for those of greater λ the β-ray results differ considerably. The possible reasons are discussed in detail, and it is considered that the coefficient of internal conversion of some γ-rays is exceedingly large, of others exceedingly small. C. A. S.

***1105. Measurements of γ-ray energies.** S. C. Curran, P. I. Dee and J. E. Strothers. *Roy. Soc., Proc. A*, **174**, *pp.* 546–558, *March* 8, 1940.—Using the method of semicircular magnetic focusing of secondary electrons, it has been possible to construct an instrument which is suitable for the

measurement of the quantum energies of γ-radiation between the limits of about 0·5 and 16·0 $\times$ 10^6 eV, and which is capable of giving a reliable estimate of the relative intensities of the components of such radiation. The detecting system consists of 3 thin-walled Geiger-Müller counters coupled to an amplifying system which records triple coincidences. The construction of the apparatus is such that it may be used for the analysis of γ-radiation emitted during the bombardment of light elements by protons, as well as that emitted by radioactive sources. The apparatus was standardized by using the γ-radiation from the active deposit of Th. Its accuracy having been thus established, it was used in the investigation of the γ-radiation from the sources ^{24}Na, ^{56}Mn and ^{38}Cl, and also the radiation emitted during the bombardment of F by high-energy protons. The results are tabulated below :—

Source	Quantum energies $\times$ 10^6 eV	Relative intensities
^{24}Na	1·46 ; 2·0 ; 3·03	1·17 : 0·27 : 1·0
^{56}Mn	0·91 ; 2·03	2·1 : 1·0
^{38}Cl	1·65 ; 2·15	3 : 4
^{19}F + ^{1}H	6·5	—

AUTHORS.

***1106. The cyclotron and some of its applications.** W. B. MANN. *Phys. Soc., Proc.*, **6**, *pp.* 125–136, 1939.

***1107. Differential pulse-amplitude selector.** A. ROBERTS. *Rev. Sci. Instruments*, **11**, *pp.* 44–45, *Jan.*, 1940.—The amplitude of pulses is selected by applying the signal to the input circuits of two thyratrons in parallel and connecting their output circuits through a push-pull transformer to the grid of an amplifier valve. The setting of the voltage limits V1 and V2 is achieved by varying the grid biases on the self-extinguishing thyratrons. The voltage limits are equal to the differences between the respective grid biases and flash voltages. When the voltage exceeds the upper limit V2, both thyratrons are triggered giving equal but oppositely phased pulses through the transformer so that the net output from the amplifier is zero. When the signal falls between the two limits set, one thyratron flashes and a signal is transmitted. With a signal below the lower limit, neither thyratron flashes and no pulse is transmitted. The voltage limits may vary between a few tenths and 125 V. It is possible to set the instrument to give reliable working with a difference between the two limits of a few tenths of 1 V in 100 V. F. S. B.

***1108. Calculation of accidental multiple coincidences.** J. JUILFS. *Phys. Zeits.*, **40**, *pp.* 697–701, *Dec.* 15, 1939.—The usual formula for the number of n-fold coincidences in a set of Geiger-Müller counters is derived, plus additional terms allowing for the influence of any systematic coincidences between several or all of the counters of the set. L. E. F.

***1109. Portable Geiger-Müller Counters.** R. B. TAFT. *Rev. Sci. Instruments*, **11**, *pp.* 63–64, *Feb.*, 1940.—Two small portable Geiger-Müller counters are described, one for battery and one for a.c. mains operation. A " stratosphere " tube, as made by G. L. Locher, is used as Geiger-Müller tube. In both sets headphones with one stage of amplification are used for recording the impulses. The high voltage for the battery set is derived from a spark coil and rectifying valve. J. B. W.

***1110. Mode of action of a Geiger-Müller counter.** C. H. COLLIE AND D. ROAF. *Phys. Soc., Proc.*, **52**, *pp.* 186–190, *March*, 1940.—The action of a Geiger-Müller counter filled with He and alcohol has been examined. A series of experiments show that ionization by collision remains the

dominant process over a large range of voltage and is sufficient to account for its action. AUTHORS.

See also Abstracts **930, 1065, 1115, 1119, 1136, 1319.**

RADIATION.

ABSORPTION.

1111. Absorption coefficient of nitrogen dioxide in the visible spectrum. J. K. DIXON. *J. Chem. Phys.*, **8**, *pp.* 157–160, *Feb.*, 1940.—The absorption coefficient of nitrogen dioxide in the visible spectrum has been measured at pressures up to 70 mm. Hg with a 40 Å spectrophotometer slit. Beer's law is obeyed in this region. The transmission as measured when using a W source, is the same as that obtained with either a high or low pressure Hg arc, except at the 4 339–4 358 Å group of Hg lines, where the absorption coefficient was found to be 15% greater with the Hg source. The absorption coefficient curve obtained with either a 40 Å or 15 Å slit is essentially sinusoidal in appearance, the absorption maxima and minima generally differing by about 10% in intensity. The maxima are separated by 700 ± 100 cm^{-1}. They appear to be due, not to the ground state of the molecule, but to groups of excited levels which are uniformly separated. AUTHOR.

1112. Variations in absorption of coloured Se glass as a function of temperature. J. ESCHER-DESRIVIÈRES AND Y. GODRON. *Comptes Rendus*, **210**, *pp.* 215–217, *Feb.* 5, 1940.—The variation in absorption by an orange Se glass was examined between 10° and 360° for light of 5 700–6 500 Å. Transmission decreases with temperature, e.g., for light of 6 200 Å it is 80% at 10°, 39% at 267° and only 2% at 360°; for light of 5 900 Å the corresponding figures are 63, 47, and 13%. Curves plotting transmission against λ for various temperatures are approximately parallel. [See Abstract 420 (1919).] C. A. S.

See also Abstracts 1123, 1148, 1150.

COLORIMETRY.

See Abstract 1142.

ELECTRO-OPTICAL AND MAGNETO-OPTICAL EFFECTS.

1113. Magneto-optical study of neutralization. F. GALLAIS AND D. VOIGT. *Comptes Rendus*, **209**, *pp.* 872–874, *Dec.* 11, 1939.—Direct measurements have shown that the magnetic rotatory power of H_2O is inferior to that of the OH-ion; the H-ion not having any magnetic rotatory power it can be foreseen that the reaction $[H]^+ \pm [OH]^- = OH_2$ must mean a diminution of the Faraday effect, It is sought in this paper to verify this hypothesis in order to obtain a method of study of neutralization. J. J. S.

See also Abstract

494B. Light relay of large area for modulation of intensity, colour or polarization. M. v. Ardenne.

EMISSION.

1114. General theory of elementary particles and the theory of the photon. G. Petiau. *J. de Physique et le Radium*, **10**, *pp.* 487–494, *Dec.*, 1939.—The wave equation of the photon is obtained as a special case of the wave equation of an elementary particle. R. P.

1115. Mass of the neutrino. Part II. J. Solomon. *J. de Physique et le Radium*, **10**, *pp.* 504–506, *Dec.*, 1939.—It has previously been shown [see Abstract 1611 (1939)] how the β-spectrum of the disintegration of the neutron into the proton is modified when different values are assigned to the mass of the neutrino. In the present paper a general relation is derived between the energy maxima of disintegration and the mean life of any radioactive β nucleus, when the mass of the neutrino is supposed to be different from zero. A. W.

1116. Interaction between radiation and matter. K. C. Kar. *Phil. Mag.*, **29**, *pp.* 169–184, *Feb.*, 1940.—Using the principles of wave statistics, the author discusses several problems on the interaction of radiation and matter. The questions of waves in the phase space and the viscosity of the phase space are considered. Expressions are developed for the vector potential of a plane stationary wave and for the coupling potential between radiation and matter, and also for the mean life of a stationary state. It is shown how the theory explains the propagation of radiation, and the law of decrease of intensity with distance. In the case of the scattering of radiation by a free electron, the theory leads to the classical Thomson formula. G. O. B.

1117. Equilibrium between electronic and mesotronic components of cosmic radiation in various media and at different altitudes. G. Bernardini, B. N. Cacciapuoti, B. Ferretti, O. Piccioni and G. Wick. *Ricerca Scientifica*, **10**, *pp.* 1010–1017, *Nov.*, 1939.—The absorption curve in Pb for vertical particles and the transition-curve in Pb for showers were measured under various absorbers and at different altitudes. An analysis of the results seems to suggest that the electronic component at sea-level is largely composed of secondaries of the primary electronic component, to a smaller extent of secondaries produced by mesotrons, while the proportion of electrons due to the disintegration of mesotrons is maximally half the number that would be expected if every mesotron disintegrates into an electron and a neutrino. [See following Abstract.] L. E. F.

1118. Nature of electronic component of cosmic radiation. B. N. Cacciapuoti. *Ricerca Scientifica*, **10**, *pp.* 1082–1089, *Dec.*, 1939.—An analysis of absorption data taken at different heights suggests that an appreciable part of the electronic component at 3 500 m. above sea-level penetrates through 10 cm. Pb. The sub-component I (knock-on electrons) of the electronic component E is estimated as 5% of the meson component M. The second sub-component D (disintegration electrons) should vary with atmospheric pressure p approximately according to $D \propto Mp^{-\frac{1}{2}}$. The third sub-component R (due to the primary electronic component) is assumed to vary exponentially with p. Then, in order to make the sum I + D + R coincide with the experimental curve for E, the sub-component R must be assumed to be preponderating at sea-level, in disagreement with the current theory of the meson, but in agreement with previous observations of Bernardini and others [see Abstracts 4549 and 4550 (1939) and preceding Abstract]. L. E. F.

1119. Many-particle disintegrations of atomic nuclei by cosmic radiation. G. Stetter and H. Wambacher. *Phys. Zeits.*, **40**, *pp.* 702–706, *Dec.* 15, 1939.—An analysis is given of several hundred disintegration "stars" in photographic emulsions obtained by the method of Blau and Wambacher [see Abstract 2849 (1938)]. The number of stars, the average proton-energy and the sum of proton-energies per star increase with height above sea-level. The "total energy" per star (sum of measured proton energies + their binding energies + an equal amount of energy ascribed to neutrons) is 60–70 eMV on the average, but "total energies" up to 670 eMV were observed. A very rough estimate of the total momentum seems to be in agreement with the conjecture that a primary particle of mass 1 (proton or neutron) is responsible for the disintegrations. The apparently homogeneous angular distribution of the most energetic protons within a star does not support the view that the evaporation of the nucleus as a whole is preceded by a local surface collision. L. E. F.

1120. Production of soft secondaries by mesotrons. J. R. Oppenheimer, H. Snyder and R. Serber. *Phys. Rev.*, **57**, *pp.* 75–81, *Jan.* 15, 1940.—Cosmic-ray evidence shows that the soft component consists primarily of electrons and γ-rays. Observations and experimental data lead to the following rough results. In addition to ordinary ionization losses, the mesotrons have a chance of transferring much of their energy to the soft component, with increased probability for lower energies. The Lorentz contracted Coulomb field of the mesotron ejecting a high-energy electron in sweeping over an atom accounts for the production of secondaries of energy $< 10^{10}$ V, but not for the very large energy transfers involved in bursts. These are roughly accounted for by the theory describing the mesotron of spin 1, which associates with transitions in which the direction of spin changes, an intrinsic dipole moment, this dipole field favouring high energy transfers. The cross-sections (valid up to mesotron energies of $\sim 10^{12}$ V, and applicable to bursts) for the production of secondaries and bremsstrahlung by the intrinsic mesotron dipole field are estimated under the assumption that the coupling of mesotron and electromagnetic field is small. The bremsstrahlung formula fails at 10^{10} V, and thus cannot be used for bursts. The evidence indicates that it is the largeness of the coupling, and not the occurrence of lengths smaller than the critical $h/\mu c \sim 2 \times 10^{-13}$ cm., that limits the applicability of quantum mechanics. N. M. B.

***1121. Converter for l.f. sinusoidal voltages and a source of sinusoidal radiation intensity.** L. Harris and A. C. Scholp. *Rev. Sci. Instruments*, **11**, *pp.* 23–25, *Jan.*, 1940.—Describes apparatus for converting a steady voltage into a fundamental sinusoidal voltage by moving a contact uniformly over a set of properly graduated resistances, one lead coming from the moving contact and the other from the mid-point of the graduated resistances. Constructional details are given. Radiation which varies sinusoidally in intensity can be obtained from a strip-filament lamp by the use of suitable continuously moving shutters. Two methods of constructing shutters giving a sinusoidal variation are described. The frequencies used vary from 0·7 to 10 c./s. J. W. T. W.

1122. Emission of ionizing radiations by the salts of ordinary metals. E. Thibaud. *Comptes Rendus*, **210**, *pp.* 174–175, *Jan.* 29, 1940.—The state of the metal (the metals examined were Al, Mg, Cu, Mn and Sb), whether thick or thin plates, or powder, or in various compounds, e.g. oxide, sulphate, phosphate, sulphide, has no effect on the coefficient of

absorption in air [see Abstract 1621 (1939)] or on the wavelength of the radiations emitted. The phenomenon is therefore specific of the metal atom. C. A. S.

See also Abstract 1134.

FLUORESCENCE AND PHOSPHORESCENCE. LUMINESCENCE AND AFTER-GLOW.

***1123. Fluorescence in colour filters.** H. Bäckström and R. Johansson. *Zeits. f. wiss. Phot.*, **38**, *pp.* 213-226, *Sept.-Oct.*, 1939.—In continuation of previous work on this subject [see Abstract 4924 (1937)] the authors have studied the relation between the density of the filter and the amount of fluorescent radiation emitted with the transmitted light. Experimental results agree with their theoretical formula. With a number of filters in series the amount of fluorescence may be greatly affected by the arrangement of the filters. The fluorescence of gelatin has been studied; it is proportional to the amount of gelatin per unit area. A coloured gelatin filter may give less fluorescence than one of plain gelatin containing no dyestuff. The experimental results obtained for a number of commercial filters are given. J. W. T. W.

1124. Polarized fluorescence of organic compounds. S. Mitra. *Indian Journ. Phys.*, **13**, *pp.* 349–389, *Nov.*, 1939.—The variation of the polarization of fluorescence of the dyestuffs with the change of (*a*) the viscosity of the solution, (*b*) the temperature of the solution, and (*c*) the concentration of the dyestuffs has been investigated experimentally. In all the cases it has been observed that the degree of polarization tends to vanish at low viscosities or high temperatures or at high concentrations of the dyestuffs while, at very high viscosities or low temperature or at very low concentrations of the dyestuffs, the polarization tends to reach asymptotically a certain limiting value which is dependent on (*a*) the nature of the dyestuffs, (*b*) the wavelength of the exciting radiation, and (*c*) the nature of the solvent. These results are discussed on the basis of Perrin's theory. The variation of the polarization with the wavelengths of the exciting radiations has also been investigated in detail. It was found that the polarization first decreases with the increase of the wavelength of the exciting radiation and increases again after reaching a minimum value which is negative and occurs at the exciting wavelengths which are characteristic for the molecules of the dyestuff. Besides the investigations mentioned above, the average life of the dyestuff molecules in the excited states, the absorption spectra of a large number of dyestuffs in glycerin solution in the u.v. region, the influence of one dyestuff molecule on the polarization of fluorescence of another dyestuff molecule and the quenching of the fluorescence of the dyestuffs in solution by the addition of foreign substance have been investigated. Author.

1125. Fluorescence of sodium formate in NaOH solution. A. Grumbach and R. Millet. *Comptes Rendus*, **210**, *pp.* 49–50, *Jan.* 3, 1940.—It is confirmed that sodium formate gives a blue fluorescence in NaOH solution. An optimum concentration has been found and the peak of the band is at about 4 600 Å. [See also Abstract 1105 (1934).] J. E.

1126. Infra-red radiations and their quenching effect on ZnS phosphors. Part II. G. G. Blake. *Roy. Soc. N. S. Wales., J. and Proc.*, **73**, *pp.* 190–205, 1939.—It has been found that having frozen-in one image on a phosphorescent screen by lowering the temperature, another image may be superimposed and frozen-in by further lowering. As the temperature

rises the successive images reappear each at the original temperature of superposition. It is shown that the momentary brightening followed by darkening produced by infra-red on a phosphorescent screen can be investigated in slow motion by lowering the temperature, e.g. to — 78°C. (solid CO_2). Spectrographic studies showed that the effective "quenching" waves for ZnS-Cu extend continuously from 5000 to 10000 Å; then there is a gap followed by another "quenching" at 15000 Å. "Energizing" radiations occur at 3600, 3900 and 4300 Å. A new method of obtaining decay curves is described, using a photographic plate and a Cu_2O cell made by the author. Experiments are described to determine the neutral point between quenching and "energizing" radiations. Comparisons were made between ZnS-Cu phosphorescent screens and panchromatic plates as regards sensitivity to different wavelengths. The ZnS screen gave the same relative response to each colour as the plate but was much slower. [For Part I see Abstract 4556 (1939).] J. E.

1127. Discharge potential, secondary emission, and fatigue phenomena of metals and luminous substances irradiated by electrons. C. Hagen. *Phys. Zeits.*, **40**, *pp.* 621–640, *Oct.* 15, 1939.—A discussion is given, and the results of experiments described, of the phenomena observed when a luminous screen is exposed to a stream of cathode rays in a high-vacuum tube. Recent practice in such tubes is dealt with and the following divisions of the subject are considered: (1) Secondary emission from metals, its measurement and the theoretical developments; (2) discharges from insulated metal screens, the results of measurements being given and the case of the unstable screen considered; (3) discharge and secondary emission from insulators (phosphorescent substances) including the influence of the screen discharge on the output of light; (4) fatigue phenomeona of the phosphorescent substances in consequence of the irradiation by electrons, which is treated experimentally and theoretically. The two chief questions to be answered are: (*a*) In what connection does the screen potential stand as regards the tension of throwing out of the cathode ray, and (*b*) by what process does the carrying away from the screen of the charges produced by the radiation come into existence. J. J. S.

1128. Behaviour of willemite under electron bombardment. E. R. Piore and G. A. Morton. *J. of Applied Physics*, **11**, *pp.* 153–157, *Feb.*, 1940.—Under scanning conditions in a specially designed tube, it was found that a willemite screen not only deviates from the potential of the accelerating electrode, but also shows potential variations on the surface. These potential variations are functions of scanning frequency and current density and may become of the order of several thousand volts. Light measurements were also taken. The dependence of the light intensity on voltage can be represented by a power law. Authors.

1129. Luminescence of solids. J. T. Randall and M. H. F. Wilkins. *Phys. Soc., Reports*, **6**, *pp.* 174–185, 1939.

1130. Luminescence under flame excitation. L. T. Minchin. *Faraday Soc., Trans.*, **36**, *pp.* 505–506, *March*, 1940.—An addendum. [See Abstract 679 (1939).] A. H.

INTERFERENCE, DIFFRACTION AND SCATTERING.

See Abstracts 1011, 1143, 1243.

PHOTOCHEMISTRY (INCLUDING PHOTOGRAPHY).

1131. Photochemistry of antimony oxide. G. Cohn and C. F. Goodeve. *Faraday Soc., Trans.*, **36**, *pp.* 433–440, *March*, 1940.—The photochemical sensitivity and the absorption spectra of the different crystalline forms or states of Sb_2O_3 have been investigated. All forms are sensitive to irradiation only when some foreign substance is present. There are two different types of photoreaction, both apparently with formation of Sb metal. The orthorhombic form of Sb_2O_3 is able to " build in " water forming an internal photo-active system. The reaction is reversed by removal of the water. With certain reducing agents an external photo-decomposition occurs with all forms of Sb_2O_3. Little or no sensitivity was shown by samples prepared by hydrolyzing $SbCl_3$ with water. With glycerol the reaction is reversed if O_2 together with water or other liquid miscible with glycerol are taken up. Authors.

1132. Splitting the CONH linkage by means of u.v. light. D. C. Carpenter. *Am. Chem. Soc., J.*, **62**, *pp.* 289–291, *Feb.*, 1940.—The absorption spectra of stearic anilide, benzylstearylamine and β-phenylethylstearylamine have been determined and the molecular areas when spread on HCl solution have been measured. These substances as monolayers have been irradiated at 2 483 and 2 537 Å and found to undergo photolysis at the CONH linkage. The products of the reaction have been identified by film potential measurements (stearic acid) and colorimetric tests (aniline) and as crystalline picrates (benzylamine and β-phenylethylamine). It seems reasonable to expect that peptides and proteins containing amino acids with light-absorbing side chains may undergo breakage of the adjacent CONH linkages in an analogous manner. Author.

1133. Photo-oxidation of H_2. H. A. Smith and A. Napravnik. *Am. Chem. Soc., J.*, **62**, *pp.* 385–393, *Feb.*, 1940.—The photo-oxidation of H_2 has been studied by exposing mixtures of H_2 and O_2 at room temperature to light of wavelength 1 719–1 725 Å. The total pressure of the reaction mixture was varied from 1 140 to 95 mm. In general, with increasing O_2 content, the quantum yields of O_3 increase while those of H_2O_2 and H_2O decrease. Lowering of the total pressure tends to increase the H_2O and H_2O_2 yields, apparently at the expense of the O_3. At pressures of 190 mm. and less, the formation of water shows chain characteristics. The temperature coefficients for the formation of the individual products have also been studied over the range 25 to 280°. The formation of O_3 has a negative temperature coefficient while those of H_2O and H_2O_2 are positive. At total pressures of 190 mm. and in a 10–90% O_2—H_2 mixture, the temperature coefficients of H_2O and H_2O_2 formation increase with great rapidity at temperatures above 230°. A mechanism is offered which explains satisfactorily the experimental results. The relation of the direct photoreaction to the mercury-sensitized and the explosive reactions is discussed. Authors.

1134. Mean life of electronically activated nitrogen. R. Audubert and C. Racz. *Comptes Rendus*, **210**, *pp.* 217–219, *Feb.* 15, 1940.—Slow thermolysis, or electrolysis of an aqueous solution, of an azide (e.g. NaN_3, KN_3 or HN_3) is accompanied by u.v. radiation, which is independent of the cation, and due to deactivation of the nitrogen. By electrolysis of an aqueous solution of NaN_3 with a special arrangement whereby the current is periodically opened and closed, the average life of the activated N is determined as $(2{\cdot}5 \pm 0{\cdot}2) \times 10^{-3}$ sec. The N thus passes through a

metastable state, which spectral analysis shows to differ from that of Strutt's active N. [See Abstract 4559 (1939).] C. A. S.

1135. Topochemical effect in post-fixation development. G. Kornfeld. *Frank. Inst., J.*, **229**, *pp.* 181–189, *Feb.*, 1940.—In alkaline fixing baths with a low concentration of thiosulphate, the course of the fixing reaction before development was found to be different at different heights of a film strip in the vertical position. A probable explanation is proposed, and the phenomenon is used to extend, for post-fixation development, the density curve to lower exposures. In an acid Elon bath the reduction of silver on the latent image competes with its reduction elsewhere more favourably at lower temperatures than at higher temperatures. The presence of oxidation products retards the first reaction in favour of the second. Author.

1136. Response of photographic materials to atomic particles. T. R. Wilkins. *J. of Applied Physics*, **11**, *pp.* 35–45, *Jan.*, 1940.—The range of validity of the photographic reciprocity law is discussed for the case of α-particle measurement, and precautions to be observed for accuracy are described; optimum grain size is 0·5 to 1 μ. Emulsions can be sensitized by soaking in 1 : 200 pinakryptol solution, the tracks of protons being thus lengthened by 8–9 fold as compared with the unsensitized plate; the method can be appiled to α-particles and deutrons. For development, a hydroquinone developer is suitable, and glass dishes, not stainless steel or plastics, are necessary to avoid fog. The application of the technique to the study of radio-colloid aggregates, to the counting of α-particles and protons, to the determination of the half-lives of radioactive elements, to the study of nuclear disintegration and to the identification of radioactive isotopes, is described. Cosmic rays can also be studied photographically, e.g. on mountains or in balloons in the stratosphere. S. J. G.

1137. Reciprocity failure of photographic materials at short exposure times. W. F. Berg. *Kodak Research Lab., Comm. No.* 746 *H. Roy. Soc., Proc. A*, **174**, *pp.* 559–568, *March* 8, 1940.—Experiments at very high intensities and at various temperatures show that for sufficiently short exposures reciprocity failure disappears. The bend-over point in the reciprocity failure curve is shown to be connected with the mobility and concentration of the interstitial Ag^+ ions, and below room temperature varies with temperature as the mobility. These results provide further confirmation that the latent image is formed by the aggregation and neutralization of silver ions on sensitivity specks. Author.

1138. Physics in colour photography. D. L. MacAdam. *J. of Applied Physics*, **11**, *pp.* 46–55, *Jan.*, 1940.—It is emphasized that the principles of physics can be applied to colour photography. In particular Maxwell and Ives' tacit assumption that any wavelength present in the colours being photographed contributes to the effective exposure of the plate in proportion to the product of the intensity of that wavelength and the corresponding sensitivity of the plate, has now been experimentally verified. The author applies these principles to the subtractive method for synthesizing colour reproduction, which has been used empirically for many years. S. J. G.

1139. Tone reproduction in colour photography. W. D. Wright. *Phot. J.*, **80**, *pp.* 25–37, *Feb.*, 1940.—The paper discusses the problems that arise when an attempt is made to control the subjective appearance of a colour photograph in some specified manner. In section 1 the pro-

cesses of colour perception and the methods of colour specification are summarized and the specification of subjective colour discussed. In section 2 the calculation of the colour obtained in a photograph either by the additive or the subtractive process is described, and the errors introduced by various modifications of the photographic processes, are indicated. In section 3, the problems facing the photographer and the photographic manufacturer are investigated when means are required to produce special subjective effects in a colour photograph. W. D. W.

***1140. New method for adjusting synchronizers, also suitable for testing focal-plane shutters.** J. A. M. VAN LIEMPT AND J. A. DE VRIEND. *Physica*, **7**, *pp.* 217–224, *March*, 1940. *In English.*—A description is given of a method for adjusting synchronizers for photoflash lamps with the aid of a falling-plate oscillograph (lending itself to self-construction), both for Compur and focal-plane shutters and, if desired, without spending flash lamps. The apparatus is also suitable for testing focal-plane shutters. [See Abstracts 4017 and 4946 (1937).] AUTHORS.

See also Abstract 1226 and

526B. Ultra-rapid camera (80 000 exposures per sec.) in technical research. R. Nierenberger.

PHOTOMETRY.

1141. Illumination from extended sources computed by the theory of the integrating sphere. F. BENFORD. *J.O.S.A.*, **30**, *pp.* 33–40, *Jan.*, 1940.—Uses the principle of the integrating sphere, viz. that each element of the sphere surface illuminates all parts of the sphere uniformly, to calculate the illumination from a disc. The principle is also applied to the problem of finding graphically the illumination due to a given arrangement of windows. J. W. T. W.

1142. Spectral luminosity factors. K. S. GIBSON. *J.O.S.A.*, **30**, *pp.* 51–61, *Feb.*, 1940.—As a result of extensive measurements by the flicker and equality-of-brightness methods, mostly in America, a certain set of average luminosity data was adopted by the International Commission on Illumination in 1924. These I.C.I. luminosity factors were incorporated in the 1931 I.C.I. standard observer and co-ordinate system for colorimetry and were accepted by the International Committee on Weights and Measures in 1933. In the period from 1935 to 1938, however, the validity of these factors was challenged by several German investigators, who believed as a result of their measurements that a new set of standard values should be adopted based on results by the flicker photometer with pure cone vision (1·2° field and daylight adaptation). The German measurements, however, were not wholly consistent and were in conflict with similar recent measurements in England and America. At the 1939 meetings of the I.C.I., the Germans withdrew their opposition to the 1924 I.C.I. luminosity factors and the Commission formally reaffirmed their validity in the photometry of lights of different colours. AUTHOR.

See also Abstract 1028.

POLARIZATION.

1143. Scattering of polarized light in colloids. R. S. KRISHNAN. *Indian Acad. Sci., Proc. Sect. A*, **10**, *pp.* 395–398, *Nov.*, 1939.—Continuing earlier work [see Abstract 1623 (1938)] the depolarization produced on scattering is studied for large anisotropic particles in the case of three different colloidal solutions. Whilst perfect agreement between theory

and experiment is not obtained the deviations are not large and may conceivably be due to a second-order effect. A. H.

1144. Conical refraction. J. R. Collins. *Am. Phys. Teacher*, **7**, *pp.* 409–410, *Dec.*, 1939.—A convenient and easily performed laboratory experiment is obtained if one examines the virtual image of a very small hole formed by a plane parallel plate of a biaxial crystal. Using a measuring microscope and a nicol prism the following information may be obtained :—(*a*) the angle of incidence at which conical refraction takes place, (*b*) the angle of the cone of rays inside (outside) a crystal for the case of internal (external) conical refraction, (*c*) the state of polarization of the light in these cones. For a crystal of known refractive indexes these quantities may be calculated by means of theoretically derived formulae and the theoretical results compared with those of experiment. A. H.

***1145. Wide-range rotatory compensators.** A. Ehringhaus. *Zeits. f. Krist.*, **102**, **2**, *pp.* 85–111, 1939. *In German.*—Two modifications of a compensator consisting of two crossed uniaxial crystal plates [see Abstract 1627 (1938)] are described. In the first, two quartz plates each 10 mm. thick are so used that path differences up to nearly 200 Na-wavelengths can be measured. The second consists of two calcite plates each 1 mm. thick and has a range of 133 Na-wavelengths with an accuracy of 0·1%. The origin and application of the interference colours produced by such compensators is described. C. B. A.

***1146. Brace's method with a variable half-shade.** Y. Björnståhl. *Zeits. f. Instrumentenk.*, **59**, *pp.* 425–430, *Nov.*, 1939.—In the use of the variable half-shade modification of Brace's method of measuring birefringence, no general formula is applicable, and different formulae need to be used according to the arrangement of the apparatus. Complete formulae are now derived for three common arrangements in which the half-shade is placed (i) between birefringent medium and polarizer, (ii) between medium and compensator, or (iii) between compensator and analyser. [See also Abstract 3663 (1939).] C. B. A.

***1147. Polarimetric investigations in the Schumann u.v. region.** R. Servant. *Ann. de Physique*, **12**, *pp.* 397–479, *Dec.*, 1939.—A spectropolarimeter for use in the Schumann u.v. region is described in detail. It employs concave mirrors and a concave grating, and is built into a case which can be evacuated, while all adjustments can be made from outside. Spectra crossed by oblique fringes are obtained, and from these all necessary data can be derived. The apparatus also includes a new type of lamp, using a condensed discharge between W electrodes. The birefringence of barytes, gypsum and quartz, and the rotatory dispersion of quartz at Schumann wavelengths are recorded, a method being described by which more accurate orientation of quartz plates can be obtained. The rotatory power of quartz reaches 776° per mm. at 1 525 Å. The rotatory dispersion of quartz is discussed in the light of the various dispersion formulae which have been proposed on the basis of measurement in the nearer u.v. region only. C. B. A.

1148. Infra-red dichroism of an iodoform crystal. Yeou Ta. *Comptes Rendus*, **209**, *pp.* 990–992, *Dec.* 27, 1939.—CH_3I crystals exhibit dichroism in the infra-red region [see Abstract 3278 (1939)]. By slow evaporation of an ethereal solution of CH_3I, hexagonal plates are obtained which have symmetry $C_3\nu$ and belong to the group C_6^6. This indicates that the axis of the crystal must be along the CH bond if the molecules orient parallel in the crystal and conserve their individuality. This has been confirmed

from a comparison of the absorption of solid CH_3I and of its solution in CCl_4. The infra-red absorption spectrum of the crystal in natural light, with the surface normal to the incident beam, shows that the band 17 175 Å, which is usually much more intense than the two neighbouring bands, has disappeared. Tilting the crystal, however, so that the surface is inclined to the incident beam, causes this band to re-appear, and its intensity increases with the angle of inclination. Using the inclined crystal, the natural light has been replaced by rectilinearly polarized light. When the electric vector of the incident wave has a component parallel to the crystal axis the band 2ν(CH) is visible, but when the electric-vector is normal to the axis it disappears. The other bands are not appreciably affected, indicating that bands due to deformation vibration δ(CH) conserve their character of depolarization. W. R. A.

See also Abstract 1124 and
579B. Polarized light for motor vehicles. H. T. Gibbs.

REFLECTION, REFRACTION AND DISPERSION.

1149. Linear extension of reflected image produced by a surface traversed by waves. F. C. Auluck. *Indian Journ. Phys.*, **13**, *pp.* 321–329, *Nov.*, 1939.—The formation of the image of a light source by reflection at a sheet of disturbed water has been investigated theoretically. The image is extended and the extension has been expressed in terms of the angle subtended by the image at the eye. Expressions have been derived for this extension for two different conditions, viz. (*a*) when the observer is facing the source, and (*b*) when his back is towards the source. Author.

1150. Optical constants of Cu-Al α-alloys. L. McPherson. *Phys. Soc., Proc.*, **52**, *pp.* 210–216, *March*, 1940.—Experimental values of the optical constants (refractive index, extinction coefficient, absorption coefficient, and reflecting power) are given for some Cu-Al α-alloys. Curves showing the variation of the constants with wavelength are shown, and the interpretation of the results is discussed briefly. [See also Abstract 3562 (1937).] Author.

1151. Resolving power of prism. W. W. Sleator. *Am. J. Phys.*, **8**, *pp.* 47–48, *Feb.*, 1940.—A simple method is given for proving the expression $R = \lambda/d\lambda = B\, d\mu/d\lambda$. The simplicity is due to the fact that angular separation and angular dispersion may be left out of the proof. A. H.

***1152. Mechanical device for rapid estimation of constants of a lens system.** E. J. Irons. *Phys. Soc., Proc.*, **52**, *pp.* 184–185, *March*, 1940.

***1153. Use of calculating machines in ray tracing.** L. J. Comrie. *Phys. Soc., Proc.*, **52**, *pp.* 246–252, *March*, 1940.—A discussion of the adaptation of simple ray-tracing to mechanical computation in the teaching of optics. It is concluded that students could usefully be taught the use of calculating machines from the beginning of their course; that hand machines would suffice; that the choice of tables is as important as that of machines and, finally, that it is not sufficient to use without examination the formulae that have been developed for logarithmic work—these must be examined in order to make full use of the machine. A. H.

***1154. Optical instruments of symmetrical construction.** T. Smith. *Phys. Soc., Proc.*, **52**, *pp.* 266–268, *March*, 1940.—The necessary and sufficient condition for freedom from aberrations at unit magnification in a holosymmetrical optical instrument is that parallel rays meeting the stop in diametrically opposite points shall intersect in the image surface.

In hemisymmetrical systems each half must be corrected for all aberrations except distortion, the object being at infinity in the stop space. AUTHOR.

1155. Physical properties and chemical constitution of alkyl ketones. D. M. COWAN, G. H. JEFFERY AND A. I. VOGEL. *Chem. Soc., J., pp.* 171–176, *Feb.*, 1940.—The refractive indices for the C, D, F and G lines at 20·0° and the surface tensions and densities over a range of temperatures have been determined for the following pure ketones: acetone, methyl ethyl, diethyl, methyl *n*-propyl, ethyl *n*-propyl, di-*n*-propyl, methyl *n*-butyl, methyl *iso*butyl, methyl *n*-amyl, methyl *n*-hexyl, and di*iso*butyl ketones. The molecular refractivities and the parachors have been evaluated. A detailed study has been made of the preparation of diethyl, methyl *n*-propyl, ethyl *n*-propyl, and di-*n*-propyl ketones by passage of the appropriate acids over manganous oxide at 400°. AUTHORS.

***1156. Simple method of coating optical surfaces with aluminium.** M. V. SIVARAMAKRISHNAN. *Indian Journ. Phys.*, **13**, *pp.* 241–245, *Aug.*, 1939.—A short history of the evaporation process of depositing metallic films on to mirrors is given. The apparatus herein described is found to be convenient for the deposition in high vacuum of most metals on various surfaces up to 6″ in dia. The metal to be deposited is evaporated from two straight parallel pieces of ½ mm. tungsten wire. At a pressure of 10^{-4} mm. of Hg the optical surface to be coated receives a good deposit when placed at a distance of about 10 cm. from the filament. The advantages of this process over chemical silvering, or sputtering are discussed with special reference to the coating of optical surfaces with Al. The apparatus described is quite simple and may be recommended for laboratory use. The author has introduced some important changes in the technique to facilitate easy repetitions of the process. AUTHOR.

***1157. Formation of a silver mirror.** J. LOISELEUR. *Comptes Rendus*, **209**, *pp.* 993–994, *Dec.* 27, 1939.—The behaviour of an ammoniacal solution of AgOH in presence of a reducing agent so weak as to act infinitely slowly has been considered in the absence of all surfaces. At the beginning of the reaction the metal particles escape precipitation, and the Ag atoms conglomerate in a crystal germ which grows to a certain degree under the influence of encounters. This degree is limited by the intervention of electrolytes (AgOH), and the aggregate stabilises itself by becoming a negatively charged micelle. The charge of the particle then undergoes a sharp change. A glass surface introduced has a negative charge which is much less than that of the micelle. The micelle necessarily encounters the glass surface, whence flocculation of the metal particle occurs on the surface in a state intermediate between metallic and colloidal. Thus a thin Ag film is built up on the glass surface reproducing the initial charge and starting a repetition of the cycle. Previous treatment of the glass surface modifies the mirror formation. Stannous hydrate, increasing the surface charge, considerably facilitates metallisation. W. R. A.

***1158. Design of wide-aperture photographic objectives.** R. KINGSLAKE. *J. of Applied Physics*, **11**, *pp.* 56–69, *Jan.*, 1940.—The meaning of "lens speed" is explained and the difficulty of obtaining high speed discussed. Thus spherical aberration increases rapidly with increasing aperture, but can be kept small by ensuring that the angular refraction of the marginal refraction at every surface shall be small. The proper choice of optical glass type for obtaining achromatism is explained, and the elimination of distortion, of oblique spherical aberration and of coma (due to variation of magnification from one lens zone to another) is discussed. The approxi-

mate size of lens fields in relation to different types of work are given. Lens types derived from the Petzval portrait lens and from the Cooke 3-component lens are described, also the 4-component air-spaced type. S. J. G.

See also Abstracts 1144, 1193.

SPECTROSCOPY.

1159. Arc spectrum of nitrogen (N I). Part II. Extreme u.v. region. M. Kamiyama. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 933, *pp.* 375–384, *Oct.*, 1939. *In English.*—Using a 1 m. vacuum spectrograph of Siegbahn type, the NI spectrum in the extreme u.v. region was investigated. Among the 237 lines observed in the region between 1 850 Å and 850 Å, about 120 lines were newly found. A considerable number of new lines were classified. A complete list of wavelengths and classifications is given. [Part I containing the Bibliography and Part III containing the discussions will be published later in the same journal.] Author.

1160. First spectrum of tin. W. F. Meggers. *Bureau of Standards, J. of Research*, **24**, *pp.* 153–173, *Feb.*, 1940.—The spectrum emitted by neutral tin atoms has been measured, compiled and analysed. Revised wavelengths and relative intensities are given for 378 lines, 341 of which were observed photographically (1 697·59 to 12 536·5 Å), and 37 of greater wavelengths (12 788·2 to 24 738·2 Å) were measured radiometrically by Randall and Wright. About 80% of these lines are classified as combinations of energy levels arising from $5p^2$, $5pns$, $5pnp$, $5pnd$, and $5pnf$ electron configurations. The average difference between observed and computed wave numbers for lines measured photographically is 0·09 cm^{-1}. Four series of the type $5p^2$–$5pns$ yield a mean absolute value of 59 155 cm^{-1}. for the ground level, $5p^2.{}^3P_0$, of neutral tin atoms. From this, the principal ionization potential of tin is calculated to be 7·297 V. Author.

1161. Normal electron configuration of Gd II. W. E. Albertson, H. Bruynes and R. Hanau. *Phys. Rev.*, **57**, *pp.* 292–293, *Feb.* 15, 1940.—The normal electron configuration of Gd II is established as $4f^75d6s$. The quantum numbers of the energy levels are deduced from a study of Zeeman effect patterns obtained with a field of 81 500 gauss. Authors.

1162. Intensity measurements in principal series of Cs in a Cs-Ne discharge. M. Beutell. *Ann. d. Physik*, **36**, 6, *pp.* 533–556, *Nov.*, 1939.—Photometric measurements in the principal series of Cs in the Cs-Ne discharge show that the method can be used for determining the true intensity ratios, since in the gas discharge there occurs a region of high Nf values in which the measured ratios are independent of pressure. Both components of the 2nd, 3rd. and 4th, members fall in this region, and their intensity ratios are deduced as 4·1, 8·7, and 15·6 respectively. Only approximate values could be obtained for the next 3 members, but they continue to increase. C. B. A.

1163. Hyperfine structure of quadrupole line 2815 Å and of other lines of ionized mercury. S. Mrozowski. *Phys Rev.*, **57**, *pp.* 207–211, *Feb.* 1, 1940.—The structure of many lines of ionized Hg is investigated by means of apparatus of high resolving power. Most of them have been found to possess complex structure. The components of the lines 2 815, 3 984 and 2 848 Å are measured and the structure analysed in terms of isotope shift and hyperfine structure. It is shown that in the case of a forbidden line of quadrupole character like the line 2 815 Å the intensities of the hyperfine components must be computed from the formulae given by Rubino-

wicz (replacing J, L and S by F, J and I). The hyperfine structure splittings of the levels $6s^2S_{1/2}$, $5d^96s^2\ ^2D_{5/2}$ and $6p^2P_{3/2}$ found experimentally are in agreement with Goudsmit's formulae and allow in the case of the $6s^2S_{1/2}$ level a very accurate evaluation of the nuclear g factors for the isotope 199. The isotopic shifts in Hg II levels are discussed. AUTHOR.

1164. Computation of quadrupole and magnetic-dipole transition probabilities. G. H. SHORTLEY. *Phys. Rev.*, **57**, *pp.* 225–234, *Feb.* 1, 1940.—The theory of quadrupole radiation is formulated in such a fashion as to make available all the methods of computation and sum rules which have been developed for electric-dipole radiation. Formulae for the strengths are given for the SLM_SM_L scheme as well as the $SLJM$ scheme. The problem of the relative strengths of the multiplets in a transition array is treated, and formulae are given that explicitly solve this problem for all possible transitions between two-electron configurations. Values for $np\,n'p \rightleftharpoons np\,n''p$, $np\,n'p \rightleftharpoons np^2$, $np\,n'p \rightarrow np\,n'p$ and $np^2 \rightarrow np^2$ are tabulated. The spectroscopic stability method and the eigenfunction method of obtaining relative multiplet strengths are given a convenient formulation; and values are computed for $np^3 \rightarrow np^3$. A root $S^{\frac{1}{2}}$ of the line strength is defined in such a way that it transforms like a Hermitian matrix component. This enables convenient computation of line strengths in intermediate coupling. The J-file sum rule is shown to hold in intermediate coupling with the same degree of generality as for the electric-dipole case. Finally, closed formulae for the magnetic-dipole strengths in LS coupling are given and the method of transformation to intermediate coupling is indicated. AUTHOR.

1165. Natural width and displacement of spectral lines. J. SERPE. *Physica*, **7**, *pp.* 133–144, *Feb.*, 1940. *In French.*—The displacement of spectral lines obtained by Weisskopf and Wigner, is contained in the non-quantized theory which forms the basis of Dirac's theory. This displacement owes its origin to the fact that in the Hamiltonian the contribution of the electromagnetic mass is counted double. This error does not appear in the classical theory recently formulated by Kramers. Kramers' theory furnishes the damping constant for a harmonic oscillator and eliminates the displacement of the former theory. L. K.

1166. Infra-red absorption spectrum of cyanogen. D. ŞTEFĂNESCU AND S. VENCOV. *Soc. Roumaine de Physique*, **40**, 73, *pp.* 25–39, 1939.—The authors have studied the infra-red absorption of gaseous cyanogen between 1 and 9μ and obtained 10 absorption bands. Burmeister's results in the infra-red, the Raman frequencies and the u.v. absorption spectrum have been used for the attribution of these bands to the frequencies of the molecule. Each individual band is specially discussed. The authors end their paper with a general review of the constitution of the CN radical. AUTHORS.

1167. Effect of ions of the lyotropic series on the infra-red absorption spectrum of water. A. M. BUSWELL, R. C. GORE AND W. H. RODEBUSH. *J. Phys. Chem.*, **43**, *pp.* 1181–1184, *Dec.*, 1939.—With a view to explaining the lyotropic series of ions the infra-red absorption spectrum near 3μ of layers (0·004–0·0008 mm. thick) of molar solutions has been examined near 3μ; (molar) KCNS, KCl, KNO_3, KBr, KI and approximately 6-molar $CaCl_2$. The molecular absorption coefficient is in a lyotropic sequence parallel to the respective halogen ion but KCNS and KNO_3 give results which are not completely interpretable. The $CaCl_2$ solution, compared

with H_2O, shows a shift and broadening of the band near $2{\cdot}67\mu$, the position of the OH radial fundamental. W. R. A.

1168. Spectrum of water vapour molecule. B. T. Darling and D. M. Dennison. *Phys. Rev.*, **57**, *pp.* 128–139, *Jan.* 15, 1940.—In this mathematical paper the vibration-rotation spectrum of water vapour is treated by the theory of semi-rigid polyatomic molecules. The potential energy is expanded as a power series in the normal co-ordinates, and the positions of band centres are calculated and found to depend on 10 quantities which are functions of the potential constants. A new feature of the treatment is the recognition of a resonance interaction between certain of the overtone bands. The 18 experimentally known band centres serve to determine the above 10 quantities and furnish self-consistency checks. No discrepancy exists between Raman and infra-red spectra. The geometric displacements corresponding to each normal co-ordinate are obtained by examination of the spectrum of D_2O. The interaction between vibration and rotation is considered, and the effective moments of inertia, and hence the first- and second- order potential constants, are calculated. The analysis of the rotational structure is supplemented by taking account of the rotational stretching. The resulting molecular constants give the valency angle 104° 31′ and the O–H distance 0·958 0 Å. Results in general are in close accord with experiment. N. M. B.

1169. Infra-red absorption spectrum of methylphenylacetylene. M. J. Murray and F. F. Cleveland. *J. Chem. Phys.*, **8**, *pp.* 133–134, *Feb.*, 1940.—The infra-red spectrum of methylphenylacetylene between 500 and 2 300 cm^{-1}. has been measured with the aid of a prism spectrometer. The results are compared with the Raman spectrum of this compound, previously measured by the authors. The results are inconclusive as regards the assignment of the fundamental whose overtone, according to Badger's hypothesis, is responsible for the resonance splitting of the frequency near 2 230 cm^{-1}. Authors.

1170. Normal vibrations of chains and infra-red spectrum of undecane. S. E. Whitcomb, H. H. Nielsen and L. H. Thomas. *J. Chem. Phys.*, **8**, *pp.* 143–152, *Feb.*, 1940.—Theory indicates that the normal modes of vibration of chain molecules fall into two classes; *end vibrations* in which the amplitude falls off exponentially from the ends towards the middle, and *chain vibrations* in which it varies harmonically as in a standing wave. The transition from one class to the other takes place *via* chain vibrations with a small number of nodes of amplitude along the chain. For a long chain we expect only those chain vibrations to show up in the infra-red spectrum for which the phase of the electric moment is constant along the chain. These considerations have been applied to predict the vibration spectra of the straight chain paraffins, assumed to consist of a zigzag chain of C atoms each carrying two H atoms in a plane perpendicular to the chain and alternately above and below it. The infra-red spectrum of undecane has been measured from 1 to 15μ on a prism spectrometer, the positions of 31 bands being determined. Accepted values of the interatomic distances and angles were assumed and force constants were adjusted to fit 4 of the fundamental frequencies to observed bands. Bands were observed near all the other fundamental frequencies predicted certainly to occur (as chain vibrations) and near 1 out of 3 that should possibly occur (as end vibrations near chain vibrations with few nodes). All but 3 of the observed bands could be accounted for as fundamentals, harmonics, or simple combination frequencies. Authors.

1171. Spectroscopic comparison of proton-attracting properties of liquids. Part II. W. Gordy and S. C. Stanford. *J. Chem. Phys.*, **8**, *pp.* 170–177, *Feb.*, 1940.—Forty-two different organic liquids are rated according to their proton-attracting power by comparing the strength of the hydrogen bonds which they form with heavy methyl alcohol. The classes of liquids studied are : aldehydes, ketones, esters, ethers and amines. The amount of perturbation which the different solvents cause in the OD vibrational band of the CH_3OD is taken as a measure of the strength of the deuterium bridges formed with the CH_3OD. The study is a continuation of a previous work [see Abstract 1215 (1939)] in which 26 similar liquids were studied, and the results agree with those of the former study in showing that according to proton-attracting power the different classes are in the order : esters < aldehydes and ketones < ethers < amines. From the study it is possible to observe the effects of unsaturation, substitution, and other structural variations on the electron donor power of the O or N atom to which the OD groups forms a bond. It is shown that the strength of the deuterium bonds formed with CH_3OD bears a close relation to the basicities of the solvents, to their solubilities for other proton donor solutes, and to their reactivity with other compounds. There appears to be no correlation between the dipole moments of the solvents and the strengths of the bonds formed with the CH_3OD. Authors.

1172. New measurements of AlO bands. D. Roy. *Indian Journ. Phys.*, **13**, *pp.* 231–240, *Aug.*, 1939.—The paper deals with new measurements of band-heads in the spectrum of AlO, and reports the existence of several bands not yet recorded in literature. A new band head equation has also been derived. Author.

1173. Absorption spectra of compounds of phosphorus. S. N. Ali. *Indian Journ. Phys.*, **13**, *pp.* 309–319, *Nov.*, 1939.—The absorption spectra of solutions of HPO_3, H_3PO_4, K_3PO_4, K_2HPO_4, KH_2PO_4, $H_4P_2O_7$ and K_2HPO_3 and of vapours of HPO_3, H_3PO_4 and KPO_3 have been studied experimentally. Absorption maxima have been observed in the case of the solutions in the region from 2 600 to 3 000 Å, and in the case of the vapours diffuse maxima of absorption have been observed in the region 2 400–2 550 Å Å. From the observed behaviour of the bands with the change of concentration of the solutions it is concluded that there is no essential difference in behaviour or structure between the acids, salts and esters formed by P and those formed by N. The significance of these results is discussed in the light of the theories of chemical combination. Author.

1174. Isotope effect in the band spectrum of SnO. P. C. Mahanti and A. K. Sengupta. *Indian Journ. Phys.*, **13**, *pp.* 331–347, *Nov.*, 1939.—From high-dispersion spectrograms of the (0, 1) band of the A system of SnO, quantitative evidence of the existence of less abundant tin isotopes of masses 116, 118, 122 and 124 has been secured. The observed intensities of the different isotopic lines are in most cases in conformity with their relative abundances. But no trace of lines due to isotopes of masses 117 and 119, which according to the mass-spectrograph data of Aston, are more abundant than the isotopes of masses 122 and 124, could be found even in regions in which they are expected to be resolved from the neighbouring isotopic lines. Authors.

1175. Near infra-red absorption of coloured solutions of inorganic salts. T. Dreisch and O. Kallscheuer. *Zeits. f. phys. Chem. Abt. B*, **45**, 1, *pp.* 19–41, 1939.—The infra-red absorption of some coloured solutions of

Fe, Mn, Cr, V, Ti, and U salts has been studied. Aqueous ferrous salts (chloride, bromide, iodide, sulphate) and ferrous ammonium sulphate show a broad absorption band from 0·68 to 1·40μ. The absorption maximum, at approximately 0·96μ, shifts to shorter wavelengths in the series Cl, Br, I. The intensity of absorption decreases in the order $FeCl_2$, FeI_2, $FeBr_2$. Aqueous $FeCl_3$ absorbs in the region 0·70 to 1·20μ with maximum at 0·77 to 0·84μ. The irregular absorption of $FeBr_3$ is discussed. Aqueous $MnCl_2$ shows no infra-red absorption. Aqueous acid $CrCl_2$ and $CrBr_2$ absorb from 0·79 or 0·77μ. Aqueous vanadyl salts ($(VOCl_2)_2$, $5H_2O$ and $VOSO_4$, $2H_2O$) show absorption maxima at 0·803 or 0·784μ, whilst vanadous salts (VCl_2, VSO_4) show absorption maxima at 0·84 or 0·862μ. Vanadic salts ($V_2(SO_4)_3$, VCl_3) do not absorb in the near infra-red. Aqueous titanous salts ($TiCl_3$, $TiBr_3$) show a weak absorption band at 0·744 or 0·738μ. The absorption spectra of uranous salts (UCl_4, UBr_4, $U(SO_4)_2$) show 3 selective absorption bands : the first (0·70 to 0·90μ) and third (1·30 to 1·80μ) show fine structure ; in the second (1·00 to 1·20μ) no fine structure is evident. Most of the solutions show some fine structure in the absorption bands, but variations are apparent for compounds of the same cation with different anions, due to hydration effects. The variation in the position of the absorption band characteristic of a given cation with different anions is discussed. W. R. A.

1176. U.V. absorption spectrum of synthetic mineral oils. E. Vellinger and B. Thomas. *Comptes Rendus*, **209**, *pp.* 882–884, *Dec.* 11, 1939.—The absorption spectrum of a synthetic oil obtained by Fischer's process is similar to that of a Pennsylvanian oil which has been somewhat refined. The synthetic oil therefore contains some aromatic hydrocarbons. A similar absorption spectrum was given by an oil obtained by the polymerization of olefines. A. J. M.

1177. Excitation of band systems of neutral and ionized N_2. R. Bernard. *Ann. de Physique*, **13**, *pp.* 5–77, *Jan.-Feb.*, 1940.—The author uses the method of spectral excitation by electronic impact to determine the energy levels and perturbations in the band spectra of N_2. He shows that the differences of the experimental results of the excitation function of the first negative bands of N_2 are due to the variations of the experimental conditions. By using very low pressures he gets a maximum of the function at 50 V. The study of the relative intensities of the bands of N_2^+ and $N_2(2P)$ enables the author to determine the energy of the exciting electrons and to ascribe a definite excitation potential to the N_2 bands in the aurora. The levels $B^3\Pi$ and $C^3\Pi$ of N_2 are found to have the energies 7·5 and 11eV respectively. The Vegard-Kaplan bands can be excited in the presence of an excess of A. The distribution of their intensities is similar to that of these bands in the night sky. L. K.

1178. Rotational structure of hydrazoic acid bands in photographic infra-red. E. H. Eyster. *J. Chem. Phys.*, **8**, *pp.* 135–142, *Feb.*, 1940.—The third and fourth harmonics of the N — H stretching frequency in N_3H, at 9547·31 and 12412·19 cm^{-1}., respectively, have been studied photographically under high dispersion. The rotational structure has been well resolved and completely analysed, to yield the rotational constants in the ground and excited states. The effective moments of inertia in the ground state have been combined with other information to determine the structure of the molecule ; the best values of the molecular parameters are : $N_1 - H = 1{\cdot}012$ Å, $N_1 - N_2 = 1{\cdot}241$ Å, $N_2 - N_3 = 1{\cdot}128$ Å, $\triangle HN_1N_2 = 110° 52'$. Author.

1179. Lattice vibrations of crystals and corresponding vibrations of their solutions. S. I. Weissman and S. Freed. *J. Chem. Phys.*, **8**, *pp.* 227–228, *Feb.*, 1940.—Crystals of hydrated europium chloride possess structures in their absorption spectrum which are faint but accurate repetitions of the intense patterns arising from electronic transitions in the europium ions. These repetitions occur on both sides of the intense patterns at intervals which are ascribed to oscillations of the lattice, thermally as well as optically excited oscillations. The spectra of aqueous solutions of europium chloride and also of europium nitrate closely parallel the structures in the spectrum of the crystals. In the region where the crystals absorb, the solutions absorb also. The structures in the spectra of the solutions are somewhat more diffuse than the corresponding structures in the spectra of the crystals. Especially is this true for the structures at the intervals corresponding to lattice vibrations. Authors.

1180. Complex structure of O -H harmonic bands of substituted alcohols, and effect of temperature on relative intensities of multiplet components. L. R. Zumwalt and R. M. Badger. *Am. Chem. Soc., J.*, **62**, *pp.* 305–311, *Feb.*, 1940.—An investigation has been made of the complex structure of the third harmonic O —H bands of ethylene chloro- and bromohydrin, methyl cellosolve, trimethylene chloro- and bromohydrin, propylene chlorohydrin, and *sym*-glycerol dichlorohydrin. These substances were all studied in the vapour state. In all cases except trimethylene chloro- and bromohydrin the substitution of a halogen or a methoxy group in the alcohol has given rise to one or more new O — H bands. Photometric studies have been made of the effect of temperature on the relative intensities of the components of the O — H bands in *o*-chlorophenol, propyl alcohol and ethylene chlorohydrin. It is found that in the vapour state at 180° the energy and free energy of the *trans* form of *o*-chlorophenol exceed those of the *cis* form by $3{\cdot}9 \pm 0{\cdot}7$ and $2{\cdot}8 \pm 0{\cdot}5$ kg. cal., respectively. [See Abstracts 2102 and 4587 (1939).] Authors.

1181. Change of u.v. absorption spectrum of acrolein with time. A. M. Buswell, E. C. Dunlop, W. H. Rodebush and J. B. Swartz. *Am. Chem. Soc., J.*, **62**, *pp.* 325–328, *Feb.*, 1940.—The change in the absorption spectrum of acrolein in water and alcoholic solutions has been determined over a period of time. The effect of hydroquinone and tannic acid on the spectrum also has been determined. The absorption due to the carbonyl of the acrolein changes with time, and the change is slowed down by the presence of an antioxidant. A band which appears at 2670 Å is probably due to the carbonyl of the polymer since the product described by Gilbert and Donleavy gives the same absorption band. Curves for propionaldehyde in water and 50% alcohol solutions for acetal in water, paraldehyde in 50% alcohol and aldol in 50% alcohol are also given for comparison. Authors.

***1182. Transfer of energy from rotation to translation by collisions.** H. Haber. *Phys. Zeits.*, **40**, *pp.* 541–551, *Sept.* 1, 1939.—In a cooled hollow-cathode discharge with an Al cathode, AlH molecules are formed at the cathode surface. Their temperature is higher than that of the gas; by observing the variation of intensity of the band-spectrum lines with pressure it is possible to determine the efficiency of the collision in reducing the rotation temperature of the molecules. Experiments with different inert gases lead to the conclusion that the efficiency of the collision depends only on the energy of the inert gas atom, but not on its mass. The spectra were obtained by means of a 110000 line Rowland grating of 641 cm.

radius. The arrangement of the spectrograph and its adjustment are described in detail. R. P.

***1183. Arrangement for spectrophotometric investigations.** E. Strohbusch. *Zeits. f. Instrumentenk.*, **59**, *pp.* 417–421, *Oct.*, 1939.—A detailed description of apparatus for accurate spectrophotometric investigations is given, the arrangement being illustrated by diagrams and photographs. W. R. A.

1184. Conditions influencing the intensity of the $^3\Pi - {}^1\Sigma$ Cameron bands of CO. G. E. Hansche. *Phys. Rev.*, **57**, *pp.* 289–291, *Feb.* 15, 1940. Conditions influencing the intensity of the $^3\Pi - {}^1\Sigma$ Cameron bands of CO in emission have been studied in detail in the electrodeless ring discharge. The bands are intense in a large discharge tube at a pressure of about 0·005 mm. or less. Under these conditions the mean free time between collisions of CO molecules is $2{\cdot}5 \times 10^{-5}$ sec. from which the lifetime of the $^3\Pi$ state is estimated as about 10 μ sec. Marked increases of intensity relative to that of other band systems in the same spectral region are produced by increasing the energy of the discharge and by lowering the pressure. This indicates that the excitation function of the Cameron system differs significantly from those of the systems with which it is compared. Author.

1185. Dissociation of diatomic hydrides and deuterides. L. Gerö. *Physica*, **7**, *pp.* 155–168, *Feb.*, 1940. *In German.*—The $A^2\triangle \rightarrow X^2\Pi$ bands of CH are rephotographed and analysed. A predissociation limit is established at the $A^2\triangle$ term at 29 500 cm^{-1}., i.e. at the energy of the most probable convergence limit of the $B^2\Sigma$ state. Branching of the $C^2\Sigma \rightarrow X^2\Pi$ system at $v = 0$, $K = 27$, is interpreted as predissociation, and anomalous isotope separation in the $A^2\triangle \rightarrow X^2\Pi$ system as originating from another $^2\triangle$ term. The (2,2) band of this system is recognized. A dissociation scheme is developed to account for all the experimental data. Examination of spectra of PbH, SnH, GeH and SiH suggests that these molecules dissociate similarly to CH. [See also Abstract 2105 (1939).] C. B. A.

1186. Luminescence and absorption of ZnS, CaS and their solid solutions. F. A. Kröger. *Physica*, **7**, *pp.* 1–12, *Jan.*, 1940. *In English.*—At −180°C CdS, Zns and the mixed crystals ZnS–CdS show emission bands which have been partially resolved into at least 5 components showing in each case an approximately constant frequency difference. The structure of the band disappears in the mixed crystals when the amount of either constituent exceeds 10%. The position of the bands and the frequency difference in the mixed crystals depend on the composition. The resolved band observed by Ewles for ZnO excited by cathode rays [see Abstract 3273 (1938)] has also been obtained under u.v. excitation with good agreement of position and frequency difference. [See following Abstract.] J. E.

1187. Luminescence and absorption of solid solutions in the ternary system ZnS-CdS-MnS. F. A. Kröger. *Physica*, **7**, *pp.* 92-100, *Jan.*, 1940. *In English.*—Mixed crystals of the system ZnS-CdS-MnS show a fundamental absorption region and a system of bands. The band system is characteristic of the Mn and practically independent of the composition of the mixed crystal. The pure crystals ZnS and CdS show fundamental absorption bands whose long-wave edges lie at 3 350 and 5 170 Å respectively. The binary system ZnS–CdS shows one fundamental absorption band only, intermediate between those of ZnS and CdS. Its position on a wavelength scale is a linear function of the composition. In the solid

solutions ZnS–MnS two overlapping bands are shown, coinciding with the fundamental bands of each constituent and independent of the composition. In CdS–MnS, however, the fundamental absorption of the crystal is shifted by the MnS and the same holds for the ternary system ZnS–CdS–MnS. The fluorescent emission of the ternary systems shows a band characteristic of the lattice and whose position varies from blue for 100% ZnS to infra-red for 100% CdS. Mixed crystals of ZnS–MnS prepared by precipitation in the cold show the same emission as that of crystals prepared in the usual way by heating the constituents together strongly. [See preceding Abstract.] J. E.

1188. Fluorescence and absorption spectra of anthracene and phenanthrene in solutions. S. Sambursky and G. Wolfsohn. *Faraday Soc., Trans.*, **36**, *pp.* 427–432, *March*, 1940.—Photographic-photometrical measurements of the fluorescence and absorption spectra of anthracene and phenanthrene in different solvents lead to the following conclusions: (1) The vibrational bands of the fluorescence spectra of anthracene and phenanthrene in all solvents have a constant spacing of 1 380 cm^{-1}., corresponding closely to the totally symmetrical Raman frequencies of these substances. (2) Anthracene shows a secondary spacing of 225 cm^{-1}. which cannot be correlated to a known Raman- or infra-red frequency of this molecule. (3) The excited electronic state of phenanthrene is double, the difference between these levels being 630 cm^{-1}. (4) The (*o*, *o*) bands in emission and absorption do not coincide, the frequency being larger in the latter. The spacing depends on the nature of the solvent and can be attributed to the energy of interaction between the inner electric field of the solvent and the electric moment of the excited molecules of the solute. Authors.

1189. Spectroscopy. *Phys. Soc., Reports*, **6**, *pp.* 137–173, 1939.—A progress review, edited by W. Jevons, containing the following 3 papers:

"Spectra of supernovae," by A. Hunter (*pp.* 137–144).

"Some recent developments in the Zeeman effect in atomic spectra," by H. E. White (*pp.* 145–154).

"The magnetic effect in diatomic spectra," by F. H. Crawford (*pp.* 155–173).

1190. Raman spectrum of diphenyl in the solid state. S. A. Aziz. *Indian Journ. Phys.*, **13**, *pp.* 247–252, *Aug.*, 1939.—The Raman spectrum of diphenyl in the solid state was studied for the first time. In all, 26 lines were recorded. Many of the lines of molten diphenyl [see Abstract 4555 (1938)] appeared in the solid state of the substance. Most of the lines were observed to be shifted in frequency in passing from the liquid to the solid state; the shift, however, is not in the same direction for all the lines. In the region of small frequencies, 4 new lines were recorded at 169, 93, 54, and 39 $cm.^{-1}$. The probable origin of these lines is pointed out. Author.

1191. Raman spectra of divalent chlorates and bromates. M. Rolla. *Gazz. Chim. Ital.*, **69**, *pp.* 779–790, *Dec.*, 1939.—Methods of preparing chlorates of Zn, Cd, Sr, and Cd and bromates of Mg and Zn, are described, the observations being made with a 3-prism Zeiss spectrograph, on solutions in water, and in alcohol and acetone previously dehydrated with P_2O_5. Mean frequencies of Raman oscillations are found to be 928·7, 612·5, 928·7 and 479·7 cm^{-1}. in water and 927·6, 609, 927·6 and 474 in organic solvents; these compare with 932, 615, 920–1 040, and 480 for monovalent chromates, previously obtained. The ω_3 line is very weak and coincident with the ω_1 (A_1) line. The author compares his results with those of previous

experimenters, and concludes that, both in the solid and the dissolved states, the ClO_3' and BrO_3' ions possess approximately a pyramid structure. D. R. H.

1192. Raman spectra of simple ethers. F. F. Cleveland, M. J. Murray, H. H. Haney and J. Shackelford. *J. Chem. Phys.*, **8**, *pp.* 153–156, *Feb.*, 1940.—Displacements, estimated intensities, and depolarization factors are listed for the main lines of diethyl ether, di-*n*-propyl ether, di-isopropyl ether, di-*n*-butyl ether, di-isobutyl ether, di-*n*-amyl ether, and di-isoamyl ether. All the frequencies in the 2 900 cm^{-1}. region are polarized, except the one near 2 970 cm^{-1}. which is, without exception, highly depolarized. Authors.

See also Abstracts 926, 930, 936, 938, 1040, 1041, 1132, 1278.

TRANSMISSION.

1193. Quartz glass with sharp cut-off at 2800 Å. A. J. Maddock. *Soc. Glass Technol., J.*, **23**, *pp.* 372–377, *Dec.*, 1939.—By the addition of a small quantity of stannic oxide to quartz a glass, similar in its physical properties to pure fused quartz, is obtained which cuts off sharply all radiation below about 2 800 Å and has a very steep transmission curve in this region. Its characteristics, methods of fusion, properties and uses are discussed. Author.

1194. Infra-red transmission of thin films of various organic materials. A. J. Wells. *J. of Applied Physics*, **11**, *pp.* 137–140, *Feb.*, 1940.—The transmission of thin films of the following materials has been measured between 400 cm^{-1}. and 3 000 cm^{-1}.; Cellophane, ethyl cellulose, cellulose acetate, Duco household cement, polystyrene, glyptal, Pliofilm, rubber, Plexiglas, methyl methacrylate polymer, XYSG Vinylite, and Shawinigan V-15 resin. The possibility of using these materials for windows in spectroscopic experiments is discussed. Author.

VISION.

1195. Theory and measurement of visual mechanisms. Part III. Properties of visual ΔI for monocular and binocular stimulation. W. J. Crozier and A. H. Holway. *J. Gen. Physiol.*, **23**, *pp.* 101–141, *Sept.* 20, 1939.—Measurements of ΔI as a function of retinal area illuminated have been obtained at various levels of standard intensity I_1, using white light and 3 monochromatic beams (wavelengths 0·465 μ, 0·525 μ, 0·680 μ) for monocular stimulation and for simultaneous excitation of the two eyes, using several methods of varying area and retinal location, with control of exposure time. For data homogeneous with respect to method of presentation, $\log \Delta I = -Z \log A + C$, where A is the area illuminated, C is a constant depending on the units in which ΔI and A are expressed and Z is a constant independent of these units. This equation is examined for various conditions of observation. The results are consistent with the view that the properties of ΔI are quantitatively determined by events central to the retina. [See Abstract 2553 (1939).] W. D. W.

1196. Regeneration of visual purple in solution. A. M. Chase and E. L. Smith. *J. Gen. Physiol.*, **23**, *pp.* 21–39, *Sept.* 20, 1939.—Measurements of visual purple regeneration in solution have been made by a procedure which minimized distortion of the results by other colour changes. Bleaching a visual purple solution with blue and violet light causes a greater subsequent regeneration than does an equivalent bleaching with light which lacks blue and violet. This is explained as due to a photosensitive sub-

stance which has a gradually increasing effective absorption toward the shorter wavelengths, but it is uncertain whether this substance is a product of visual purple bleaching or is present in the solution before illumination. The absorption spectrum of the regenerating material shows only a concentration change during the course of generation. The kinetics of regeneration is usually found to be that of a first order process. *In vivo*, the frog retina shows no additional oxygen consumption while visual purple is regenerating. W. D. W.

1197. Rod and cone electroretinograms and pigment migration in frogs. P. O. Therman. *J. Cell. and Comp. Physiol.*, **14**, *pp.* 253–259, *Dec.* 20, 1939.—The size of the *b*-wave in the electrical response of the frog's retina was measured for 71 eyes for both a standard red and standard blue stimulus. In some cases, adrenaline had been injected into the lymph sac in order to expand the pigment epithelium and to cause cone contraction. Tests were then made to determine whether the adrenaline had affected the state of adaptation as measured by the ratio of the red and blue responses. No changes were observed and it is concluded that the protective rôle of the pigment must be negligible. W. D. W.

X-RAYS.

***1198. Contribution of photo-electrons from sulphur to X-ray ionization.** L. H. Gray. *Brit. J. of Radiology*, **13**, *pp.* 25–30, *Jan.*, 1940.—The investigation was carried out by means of a drum-shaped ionization chamber having the cylindrical wall of graphite and the flat walls of graphite, sulphur, etc., according to circumstances. Two qualities of radiation were used, viz. 190 kV with 1·5 mm. Cu. filter and 117 kV with no additional filter. At the higher voltage flat walls of S gave 2·91 times more ionization than graphite, and at the lower voltage 6·08 times more, corrected in each case for the graphite cylindrical wall. In other experiments paper 14 μ and 70 μ thick was placed between the S and ionization cavity, and it was found that in the latter case the ionization was about the same for each radiation quality, viz. 1·06 and 1·03 compared with 1·00 for graphite. Skin from a mouse tail gave 1·09 and 1·36 respectively. A table gives the ratio of the contributions of photo-electric absorption and scattering to the ionization in C, N, air, O, S and A. G. E. B.

1199. Applications of X-ray technique to industrial laboratory problems. H. P. Rooksby. *Roy. Soc. Arts, J.*, **88**, *pp.* 308–336; *Disc.*, 336–338, *Feb.* 16, 1940.—An account of extensive research in X-ray crystallography and a general survey of the whole subject. The uses of X-ray diffraction patterns are given under the headings of: (1) identification of the chemical compounds present. (2) distinction between different crystalline forms of the same chemical compound. (3) Formation of solid solutions and alloys. (4) The crystal size or state of subdivision of a material. (5) The presence of lattice distortion. (6) Fibre structure. The method requires less material than is usually necessary for a chemical analysis, and is of especial value in cases where there is a change of phase, such as that brought about by a temperature change, without a change of chemical composition. Whilst X-ray analysis is sometimes the only possible course, in other cases it may supplement chemical, spectroscopic and microscopic examinations. Examples are given of the various cases and finally brief mention is made of the assistance of X-ray crystallography in the study of the structure of matter. E. H. W. B.

See also Abstracts 949, 963, 965, 1011, 1306, 1307, 1311.

HEAT.

CALORIMETRY.

See Abstracts 955, 1205, 1213, 1223, 1224.

CONDUCTION.

1200. Senftleben effect. C. J. Gorter. *Ned. T. Natuurk.*, **7**, 3, *pp.* 89–95, *Feb.*, 1940.—The effect consists of a decrease of the thermal conductivity and the viscosity of O_2 in a magnetic field. The decrease is at first proportional to the square of the field intensity, but reaches saturation at a decrease of about 1%. The field intensity for which this saturation is reached is proportional to the pressure. A brief summary is given of the explanation, as suggested by Gorter, and worked out in detail by Zernike and van Lier [see Abstract 4354 (1939)]. According to this theory the effect is due to the precession of the paramagnetic molecules about the axis of the magnetic field, which makes the collision cross-section equal for all molecules, whereas in the absence of a field those molecules whose axis happened to point in their direction of motion had an exceptionally small cross-section for collision, and hence contributed to the transport more than the average. The theoretical formula agrees with the experimental curves quite well as to shape, but less well in scale. This is probably due to the simplifying assumptions involved in the theory. R. P.

1201. Heat conductivity of liquid He II. W. H. Keesom and B. F. Saris. *K. Onnes Lab. Leiden, Comm. No.* 257*d. Physica*, **7**, *pp.* 241–252, *March*, 1940. *In English.*—The authors examined the dependence of the heat conductivity of liquid He II, under about its saturated pressure. on the temperature and on the heat flow, in the range between 1·2° K, and the λ-point. The heat conductivity depends on the heat flow in the whole temperature range mentioned, decreasing with increasing heat flow. As a function of the temperature it has a very pronounced maximum at 1·92°K. Measurements were carried out with 4 capillaries of different length and width. The influence of the diameter of the tube on the heat conductivity is zero for such tubes as were experimented with, at temperatures of 1·4 and 1·6°K. Between 1·8°K. and the λ-point there is a definite but small influence. The bearing of this experimental fact on the theory of the phenomenon is discussed. It is likely that the effect of the length of the tube on the heat conductivity, for lengths from 1·8 to 35 cm., is zero ; if not, it is small and constant over the whole temperature range and for every temperature gradient. [See also Abstract 2070 (1938).] Authors.

1202. Thermal conductivity of poorly conducting alloys between 3° and 20°K. J. Karweil and K. Schäfer. *Ann. d. Physik*, **36**, 6, *pp.* 567–577, *Nov.*, 1939.—The thermal conductivities of metals likely to be used in the construction of low-temperature apparatus are determined by a method of stationary heat flow over the temperature range 3° to 20°K. The metals tested are iron, German silver (16% Ni, 64% Cu, 20% Zn), steel (0·4 C, 0·2–0·35% Si, 0·5–0·7% Mn), silver bronze (46% Cu, 41% Zn, 13% Ni) and contracid (60% Ni, 15% Cr, 16% Fe, 7% Mo), the conductivities at 5°K. being respectively, 0·431, 0·018, 0·016 5, 0·010 5 and 0·003 W/cm. deg. C. and each has a positive temperature coefficient over the range studied. The electrical resistivity is also determined and the Lorenz number calculated. For iron its value is $2{\cdot}7 \times 10^{-8}$ W. ohm. deg^{-2}.

at 5°K. compared with $1{\cdot}69 \times 10^{-8}$ at 81·5°K. The value is found to be greater for the alloys, the highest being $9{\cdot}9 \times 10^{-8}$ for German silver at 20°K., but all values decrease with decrease in temperature, that of German silver falling to $4{\cdot}1 \times 10^{-8}$ at 3°K. The present results, when considered in relation to those of Lees [see Abstract 1677 (1908)], indicate the existence of a maximum in the curve of Lorenz number against temperature. R. W. P.

See also Abstracts 1205, 1218.

CONVECTION.

1203. Distributions of temperature and vapour pressure around a horizontal wet cylinder. R. W. Powell. *Phil. Mag.*, **29**, *pp.* 274–284, *March*, 1940.—Experiments are described in which unventilated thermocouple psychrometers are used to determine the temperature and vapour pressure distributions above, below, and to one side of the wet surface of a horizontal cylinder. The presence of a convection current passing over the surface in a downwards direction is revealed when the surface is cooled to a temperature well below that of the air. When the surface temperature is raised, a temperature is reached at which very little movement of the air occurs. Under the conditions of the present experiment this occurred when the surface temperature was just over 1°C. below the temperature of the surroundings. With further increase in surface temperature the convection currents change to an upward direction. It is shown that the rate of evaporation falls to a minimum value in the region of little air-movement, and, on the assumption that the whole of the moisture loss takes place by diffusion, the experimental data for the vapour pressure gradients near the wet surface are seen to lead to values of the correct order of magnitude for the coefficient of diffusion of water vapour into air. Author.

1204. Propagation of temperature changes through textiles in humid atmospheres. Part I. G. King and A. B. D. Cassie. **Part II.** A. B. D. Cassie. **Part III.** A. B. D. Cassie and S. Baxter. *Faraday Soc., Trans.*, **36**, *pp.* 445–465, *March*, 1940.—In Part I a study is made of the rate of pick-up of water vapour by wool fibres when water vapour alone is in contact with the fibres. The time required for the fibres to come to equilibrium with the water vapour when a change of pressure occurs is shown to be entirely dependent on the rate of loss of heat of absorption. When allowance is made for the effect of heat of absorption it is found that the fibres attain equilibrium in a time considerably less than 15 sec.; how much less cannot be estimated. The forms of regain-time curves which have hitherto been observed are shown to be determined entirely by the external factors of diffusion and rate of heat loss, and they bear no relation to the structure of the fibre colloids. In Part II mathematical theory is given for the propagation of temperature and water-vapour concentration changes through textile materials when an air-water vapour mixture flows through the textile under a mechanically applied pressure difference. The results show that a change in temperature or concentration is propagated through the textile with a fast and a slow component. The physical significance of the two components is discussed. In Part III experiments are described which verify for wool and cotton the above theory of propagation of temperature changes in textiles. The formulae developed by Henry for the case of diffusion have been verified for cotton.

Henry's final formulae have been rearranged to fit more readily with their physical interpretation and with experimental results. AUTHORS.

See also Abstracts **971, 981, 1205.**

DILATATION.

See Abstract 1205.

TEMPERATURE.

1205. Heat. R. W. POWELL. *Phys. Soc., Reports,* **6,** *pp.* 297–328, 1939.

***1206. Measurement of low and high temperatures.** *Ned. T. Natuurk.*, **7,** 1–2, *pp.* 1–64, 1940.—A symposium consisting of 5 contributions.

" The temperature scale—He thermometer—International temperature scale," by W. H. KEESOM (*pp.* 2–13).—Deals with the He thermometer and the corrections to be applied to pass from the gas scale to the thero-dynamic scale. The international temperature scale is also described.

" Measurement of temperature in the region of liquid He," by W. P. J. LIGNAC (*pp.* 14–22).—Survey of the different types of thermometer used in the region of liquid He, paying special attention to the vapour pressure of He.

" Temperature scale below 1°K.," by H. B. G. CASIMIR (*pp.* 22–34).—Deals with the methods for obtaining the relation between the thermo-dynamic temperature and the magnetic properties of a paramagnetic salt cooled to below 1°K. by adiabatic demagnetization. Both theoretical and experimental methods are considered.

" International temperature scale for temperatures above 1 000°C.," by W. DE GROOT (*pp.* 34–48).—Discusses the principles underlying the international temperature scale above 1 063°C. as defined by optical pyrometry and gives a useful list of fixed points as recently determined in different laboratories.

" Optical pyrometry," by J. G. HAGEDOORN (*pp.* 49–64).—Measures at each wavelength the brightness of a body emitting light. It is thus possible to obtain the true temperature and the brightness at every wavelength. Suitable apparatus for doing this has been designed.

G. G.

***1207. New type of thermostatic control gear.** K. KLEIN. *Zeits. f. Instrumentenk.*, **59,** *pp.* 469–471, *Dec.*, 1939.—The head of the instrument, containing the regulating Hg contact is of unusual simplicity. The capillary is integral to a slotted cock. By bringing the same into position the Hg level inside and outside the capillary can be equalized, thus adjusting the instrument roughly to a certain temperature range. Final adjustment is effected by varying the position of the contact wire. The instrument can be sufficiently submerged in the thermostat liquid to render effects of outside temperature negligible. For low temperatures, downto −130°C., the submerged part of the instrument body is filled with alcohol. The use of weak currents, and amplification is recommended. H. O. S.

***1208. Thermo-elements of high sensitivity for radiation measurements.** G. ROSENTHAL. *Zeits. f. Instrumentenk.*, **59,** *pp.* 432–439, *Nov., and pp.* 457–463, *Dec.*, 1939.—Following closely Cartwright's design [see Abstract 373 (1935)], a small strip of thin gold foil, thickness 0·000 3 mm., with blackened surfaces is used as receiver; connected to it are two thermo-wires of 10–20 μ dia. A most detailed description is given of every phase of construction such as: drawing of micro-wires, soldering them on to the

copper wire supports, blackening the gold foils, " welding " thermo-wires and receiver together, etc. Working conditions, applications, and calibration are thoroughly discussed. The specific sensitivity of a number of elements of this description was found to be between 1·5 and 3 times greater than that of all other known types. H. O. S.

***1209. Theory and application of extended-surface thermocouples.** H. Emmons. *Frank. Inst., J.*, **229**, *pp.* 29–52, *Jan.*, 1940.—An extended-surface thermocouple is one in which one of the junctions is so extensive that appreciable temperature differences exist between various parts of that surface. The author shows how the true temperature can be derived, firstly for a thermocouple formed by rectangular metallic slabs, and then for other common forms of long narrow thermocouple junctions. The theory leads to a method of designing a junction which shall read any desired weighted average along the junction, and the conclusions are found to be in agreement with experimental measurements. The problem of measuring the average surface temperature of a pipe is specially considered and it is shown to be possible so to shape a nickel pipe and copper insert that the single reading of these two elements corresponds to the average temperature of the pipe. R. W. P.

***1210. Stability of base-metal thermocouples in air from 800° to 2 200°F.** A. I. Dahl. *Bureau of Standards. J. of Research*, **24**, *pp.* 205–224, *Feb.*, 1940.—A study has been made of the changes in the e.m.f. of chromel-alumel and iron-constantan thermocouples heated in an oxidizing atmosphere at various temperatures and for various periods of time. The thermocouples were held at definite temperatures, ranging from 800° to 2 200°F, in steps of 200°F. Calibrations were made of the thermocouples in their original condition, and again after heating them at each temperature for total times of 10, 50, 100, 200, 400, 600, 800, and 1 000 hr. or as long as the thermocouples remained serviceable. The thermal e.m.f. of each element against Pt was measured in order to determine the relative stability of the individual elements. A few tests were made to determine the effect of wire size on the stability. The effects of changing the depth of immersion of thermocouples after they had been used under controlled conditions were also studied. Since all tests were made in an atmosphere of clean air, the results give no information on stability except under oxidizing conditions. Author.

1211. Liquid helium. H. Jones. *Phys. Soc., Reports*, **6**, *pp.* 280–296, 1939.

See also Abstracts 1025, 1201, 1202, 1212, 1218.

THERMOCHEMISTRY.

1212. New method of calculating combustion temperatures. H. Zeise. *Zeits. f. Elektrochem.*, **45**, *p.* 893, *Dec.*, 1939.—A correction. [See Abstract 2943 (1939).]

1213. Specific heats of aromatic acids and their ammonium salts and atomic heat of nitrogen. S. Satoh and T. Sogabe. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 940, *pp.* 449–457, *Dec.*, 1939.—The mean specific heats of benzoic, cinnamic, ortho-phthalic, and iso-phthalic acids and their ammonium salts were determined. The atomic heat of N was deduced from the differences between the molecular heats of ammonium salts and their respective acids. It was found that when the atomic heat of N is deduced from acid ammonium salts and neutral ammonium salts, it has the smallest value (1·7) in aromatic acids, while

in aliphatic acids it has the largest value (6·4) ; that when it is deduced from acids and acid ammonium salts, it has the largest value(5·3) in aromatic acids, while in aliphatic acids it has the smallest value (1·8) ; and that when they are deduced from acids and neutral ammonium salts they have the intermediate values in both aromatic (3·3) and aliphatic (4·2) acids, which are very near to the provisional value (3·5) found in the study of various nitrides. [See Abstract 3369 (1939).] AUTHORS.

1214. Thermal data of certain molecular compounds. A. N. CAMPBELL AND A. J. R. CAMPBELL. *Am. Chem. Soc., J.*, **62**, *pp.* 291–297, *Feb.*, 1940.—The object of this paper is to obtain some measure of the energy change involved in the formation of organic addition compounds. Using the systems phenol-urea, phenol–*p*-toluidine, β-naphthylamine–*p*-nitrosodimethylaniline,and salicylic acid-acetamide, experimental determinations have been made, both for reactants and products, of heat of solution, specific heat, and solubility diagram (in the case of two systems only). The heats of formation at room-temperature and at absolute zero, have been calculated, the latter approximately only. The equilibrium diagrams for the systems phenol–urea-water and salicylic acid–acetamide-water at 20°, have been outlined. In both cases the molecular compound is stable at room temperature. AUTHORS.

1215. Cool flames. Part III. M. MACCORMAC AND D. T. A. TOWNEND. *Chem. Soc., J., pp.* 143–150, *Feb.*, 1940.—In Parts I and II [see Abstract 1715 (1939)] evidence was adduced that the two-stage process of ignition depending on prior " cool " flame formation is the same whether the " cool " flames are induced (a) spontaneously at high temperatures and suitably low pressures or (b) artificially by means of a heated wire at room temperature and at high enough pressures. In both circumstances ignition is the outcome of the initiation of a second flame in the " cool " flame products. The phenomena associated with the development of the second flame, now termed the " blue " flame, are much more marked in ether-oxygen than in ether-air mixtures ; moreover, the " blue " flame is distinguishable from the " cool " flame by a marked increase in the volume of its products. In mixtures of adequate oxygen content the " blue " flame may in narrow tubes overtake and extinguish the " cool " flame, leading to a normal flame ; this normal flame is not self-propagating and dies out. In wider tubes the normal flame may degenerate into a " cool " flame, the two-stage process then being repeated again and again, resulting in oscillatory propagation. Under conditions where the products of the " blue " flame are released and constant pressure maintained, it is shown that the " blue" flame is not self-propagating ; it is always preceded by a " cool " flame, the distance between the two being a function of pressure and mixture composition. The " blue " flame is now recognized as having characteristics differing from both " cool " and normal flames. [See following Abstract.] AUTHORS.

1216. Cool flames. Part IV. M. MACCORMAC AND D. T. A. TOWNEND. *Chem. Soc., J., pp.* 151–156, *Feb.*, 1940.—As an outcome of the work described in previous papers [see preceding Abstract] it has been possible to develop a new method involving a cooled reaction tube incorporated in a flow system for studying the chemical characteristics of the two-stage inflammation of higher hydrocarbons and their derivatives. The main advantage of the method is that, not only is the whole of the reaction zone visible, but subsidiary surface reactions and slow combustion are reduced to a minimum. The method has conveniently been applied in the first

place to an examination of the differences between the " cool " and the " blue " flames of ether ; and it is shown that although the " cool " flame produces aldehydes and peroxides, these are decomposed again in the "blue" flame together with much of the rest of the ether. The "blue" flame is therefore recognized as essentially a zone of luminous decomposition in which heat is evolved, oxidation playing a secondary rôle. In the presence of sufficient oxygen, however, the reactions which start as a spontaneous decomposition of certain of the " cool " flame products lead to normal ignition. AUTHORS.

See also Abstract 936.

THERMODYNAMICS.

1217. Second law of thermodynamics and the distinction between past and future. C. F. v. WEIZSÄCKER. *Ann d. Physik*, **36**, 3–4, *pp.* 275–283, *Oct.*, 1939.—A discussion of the consequences of the irreversibility of time on the application of the second law of thermodynamics. R. W. P.

1218. Thermodynamics of thermomechanical effects in He II. J. MEIXNER. *Ann. d. Physik*, **36**, 6, *pp.* 578–584, *Nov.*, 1939.—The thermomechanical phenomena, which have been observed in liquid He II when flowing in narrow capillary tubes, are explained by means of a theory based on analogous assumptions to those made for the explanation of the Peltier and Thomson effects of thermo-electricity. R. W. P.

1219. General equation of state : equations for ammonia and steam. J. L. FINCK. *Frank. Inst., J.*, **229**, *pp.* 201–221, *Feb.*, 1940.—A continuation of a previous paper [see Abstract 2518 (1938)]. The basic idea in the two papers is to enlarge the assemblage of thermodynamic states by including the so-called " metastable " states. Considering a system, in one or two phases, which has a single type of transformation, the writer develops an equation of state of the form $\eta = a + bv + cp + dpv + (e + fv + gp + hpv) \ln T$, where p, v, T are three independent variables and a, b, c, etc. are constants. The latent heat at p, T = constant is $\lambda_{p,T} = T(v_2 - v_1)[b + dp + (f + hp) \ln T]$, which is derived from the equation of state. The available thermodynamic data on ammonia and steam are used to check these equations. It is found that within the saturated region the agreement is quite satisfactory, whereas for the superheated region the agreement is not so good. AUTHOR.

1220. Repulsive forces between isotopic molecules. R. P. BELL. *Roy. Soc., Proc. A*, **174**, *pp.* 504–509, *March* 8, 1940.—It is pointed out that the charge distribution in a diatomic molecule will be a function of the zero-point energy of the nuclear vibration, and hence that the forces of attraction and repulsion between two such molecules will depend upon the nuclear masses. In the case of the Coulomb repulsion the magnitude of this effect is estimated by the quantitative treatment of a simple model. Calculated numerical data are given which indicate that this effect of the nuclear mass should lead to a measurable difference between the second virial coefficients of H_2 and D_2 though there are several other factors which would also contribute to the observed difference. AUTHOR.

1221. Kinetics of phase change. Part II. Transformation-time relations for random distribution of nuclei. M. AVRAMI. *J. Chem. Phys.*, **8**, *pp.* 212–224, *Feb.*, 1940.—Following upon the general theory in Part I [see Abstract 498 (1940)] a considerable simplification is here introduced in the treatment of the case where the grain centres of the new phase are randomly distributed. Also, the kinetics of the main types of crystalline growth, such as

result in *polyhedral, plate-like* and *lineal* grains are studied. A relation between the actual transformed volume V and a related *extended volume*, V_{1ex} is derived upon statistical considerations. A rough approximation to this relation is shown to lead, under the proper conditions, to the empirical formula of Austin and Rickett. The exact relation is used to reduce the entire problem to the determination of V_{1ex}, in terms of which all other quantities are expressed. The approximate treatment of the beginning of transformation in the isokinetic range is shown to lead to the empirical formula of Krainer and to account quantitatively for certain relations observed in recrystallization phenomena. It is shown that the predicted shapes for isothermal transformation-time curves correspond well with the experimental data. AUTHOR.

1222. Entropy of long-chain compounds in the gaseous state. M. L. HUGGINS. *Kodak Research Lab., Comm. No.* 692. *J. Chem. Phys.*, **8**, *pp.* 181–187, *Feb.*, 1940.—Equations are derived for the entropy of long-chain compounds in the gaseous state at 25°C. (1) The translational entropy, computed classically, varies with chain length according to the relation $S_t = a + b \ln n$. (2) The entropy of rotation of the molecule as a whole, calculated statistically, assuming either a ball-like molecule or absolutely random kinking, is also linear with respect to $\ln n$. (3) The entropy of internal vibrations, assumed (following Pitzer) to be an additive function of contributions associated with the various types of bonds and bond angles present, obeys the equation $S_{iv} = a + bn$. (4) The entropy of internal randomness, for randomly-kinked molecules with no rotation, with hindered rotation, or with completely free rotation, is likewise linear in n. The equation deduced for long-chain paraffins, containing but one adjustable constant (connected with the degree of hindrance of the rotation about the C — C bonds) agrees quite well with values deduced from specific heat data for short-chain paraffins. AUTHOR.

1223. Thermal data of guanidine carbonate, glutamic acid hydrochloride, ornithine dihydrochloride, *d*-lactic acid and *l*-lactic acid. H. M. HUFFMAN, E. L. ELLIS AND H. BORSOOK. *Am. Chem. Soc., J.*, **62**, *pp.* 297–299, *Feb.*, 1940.—The heat capacity data between 90 and 298·1°K. for the above organic compounds are presented. The entropies of these 5 compounds at 298·1°K. have been calculated. A preliminary value (4 030 cal./mol.) for the heat of fusion of $d(l+)$-lactic acid is given. AUTHORS.

1224. Thermal data of ethylene dichloride and ethylene dibromide. K. S. PITZER. *Am. Chem. Soc., J.*, **62**, *pp.* 331–335, *Feb.*, 1940.—The thermal behaviour of ethylene dichloride and ethylene dibromide was investigated from 15°K. to room temperature, for which range values of the heat capacities are given. The following melting points (0°C. = 273·10°K.) and heats of fusion were determined : $C_2H_4Cl_2$, 237·2 ± 0·1°K., 2 112·0 ± 2 cal./mol ; $C_2H_4Br_2$, 283·0 ± 0·2°K., 2 615·8 ± 5·0. The following temperature and heat of transition values were determined : $C_2H_4Br_2$, 249·54 ± 0·10°K., 436· 8 ± 2·0 cal. /mol. From these data, the following values of entropy at 298·1°K. were calculated : $C_2H_4Cl_2(1)$, 49·84 ± 0·15 cal./deg. mol. ; $C_2H_4Br_2(1)$, 53·37 ± 0·20 cal./deg. mol. Ethylene dichloride shows no sharp transition but has a peak in the heat capacity curve near 177·K. which may correspond partially to the transition in ethylene dibromide. A possible explanation of the transitions is offered. AUTHOR.

1225. Thermodynamic properties of substances. Part III. Vapour volumes as functions of reduced temperature alone. H. A. Fales and C. S. Shapiro. *Am. Chem. Soc., J.*, **62**, *pp.* 393–406, *Feb.*, 1940.—The reduced vapour volume of chemically different substances is found to be an exponential function of reduced temperature alone. The form of this function is identical with those for vapour pressure and for volume ratio $\ln V_g/V_{cr} = k''(1-\tau^2)^{m''}/\tau^{n''} = x$; $V_{gas} = V_{cr}\cdot e^x$. The accuracy of this equation is well within experimental limits; it is in good agreement with vapour volume equations of other investigators. When compared with the volume ratio equation it is found to give analogous results as regards average and regional accuracy and range of application. Its advantage lies in the fact that V_{gas} is expressed as a function of one independent variable only. The parameters k'', m'', n'' of this equation have the same characteristics as the constants of the vapour pressure and of the volume ratio equations; they vary only slightly with chemical properties of substances; the constant k'' increases in the same order as the critical coefficient and the heights of ordinates $\ln V_g/V_{cr}$, but there is no simple mathematical relationship between K_{cr} and k''. The three properties, vapour pressure, vapour volume and volume ratio, exhibit striking similarity along the whole saturation line, since not only the mathematical expressions of these functions are identical, but the respective parameters are of the same order of magnitude; further, the geometrical shape of the curves $\ln P_{cr}/P_s$, $\ln V_g/V_{cr}$, $\ln V_g/V_{liq.}$ is similar and their relative order to each other is identical for every substance here studied; finally, for each one of these properties the successive order of liquids in the co-ordinate system is the same with but few exceptions. The constants k'' and n'' for vapour volume are nearly equal to the respective constants for pressure and the constants m'' are nearly half the others. However, in no case have the ratios k'/k'', n'/n'', m'/m'' assumed the integral values 1, or 2. Their averages for 30 liquids are respectively: 1·08; 0·98; and 2·09. [See Abstract 2515 (1938).] Authors.

1226. Reactions in solids. N. F. Mott. *Phys. Soc., Reports*, **6**, *pp.* 186–211, 1939.

1227. Absolute rates of heterogeneous reactions. Part II. Electrode reactions. G. E. Kimball. *J. Chem. Phys.*, **8**, *pp.* 199–204, *Feb.*, 1940.—The theory of the first paper of this series [see Abstract 3787 (1938)] is extended to include reactions at electrode surfaces. The resulting expression for the rate of an electrode reaction includes both activation-controlled and diffusion-controlled reactions. The problem of the effect of stirring rate on reaction rate is discussed. The results are applied to the theory of reactions at "floating" electrodes, e.g. the solution of metals in acids. It is shown that the reaction rate expressions at such electrodes are of a very complex form, but can be approximated in special cases. It is found that the rate of such a reaction will in general depend not only on the concentration of the principal reactants, but also on the concentration of every ion in the solution. Author.

See also Abstracts 947, 1211, 1212.

VAPORIZATION AND CONDENSATION.

1228. Evaporation from earthen jugs. H. Gupta and A. Chandra. *Indian Journ. Phys.*, **13**, *pp.* 305–308, *Nov.*, 1939.—A theory of the evaporation of water from earthen jugs is given and the results expected

according to the theory have been found to agree fairly with those observed experimentally by the authors. AUTHORS.

1229. Partial vapour pressures from nicotine solutions at 25°. L. B. NORTON, C. R. BIGELOW AND W. B. VINCENT. *Am. Chem. Soc., J.*, **62,** *pp.* 261–264, *Feb.*, 1940.—The partial vapour pressures of nicotine and water in all their binary solutions at 25° have been determined by the dynamic method. The deviations from Raoult's law are found to be very large and in the direction of higher vapour pressures for both components. The results are shown to agree with the Duhem equation. The activity coefficients of nicotine in dilute solutions are found to decrease very rapidly with increasing concentration. With increasing percentages of nicotine the loss of nicotine relative to that of the water first increases rapidly, then remains nearly constant over a long range, and finally increases very rapidly during free evaporation. AUTHORS.

See also Abstracts 1012, 1013, 1156, 1203, 1205.

ACOUSTICS.

1230. Form and propagation of sound waves in a space limited by absorbing surfaces. J. BRILLOUIN. *J. de Physique et le Radium,* **10,** *pp.* 497–503, *Dec.*, 1939.—Starting from the general velocity potential equation an examination is made of various problems related to the propagation of forced vibrations in a space limited by absorbing surfaces. The absorption is defined by the impedance of the limiting surface. The existence is shown, in the space limited by planes, of non-uniform plane waves of special structure, with elliptic vibration in a plane containing the direction of propagation, amplitudes following an exponential law in the direction of the plane of the wave containing the elliptic trajectories, uniformity in the direction of the plane of the wave normal to the plane of the trajectories, phase velocity and velocity of energy propagation equal and less than the velocity of sound. These waves, in the space considered, play a similar part to that of plane uniform waves in spaces limited by rigid planes. The calculation finally gives, for spaces not totally enclosed, the different forms of progressive waves, with their phase-velocity and attenuation, and for totally enclosed spaces the forced vibrations. A. W.

***1231. New electronic musical instrument.** E. L. KENT. *Acoustical Soc. of America, J.*, **11,** *pp.* 352–356, *Jan.*, 1940.—An instrument is described which was designed to give a performance comparable to that of a pipe organ. The method of tone generation adopted is the mechanical modulation of a h.f. carrier. Polar oscillograms of the diapason tones of a pipe organ are transferred photographically to a master plate of insulating material coated with a thin layer of metal. An etching process then leaves the wave forms of the different tones as islands of metal surrounded by metal but insulated from the surrounding metal by the etched lines. A similar metal-coated plate has a pattern of radial scanning bars connected by concentric rings and is used as a rotor, the first plate being the stator. In practice, both sides of the plates are utilized in order to economize space. Electrically a ring of scanning bars on the rotor is connected to a

h.f. oscillator and an island on the stator to a valve detector, amplifier and loud-speaker. Simple theory shows the modulation to be approximately proportional to the capacity change between the screening bars and the island. A multiple use of the rotors is possible if different carrier frequencies are employed. The tones generated can easily be "voiced", as in a pipe organ, and many new tone colours are available since tones are not limited to pipe or reed tones. For a complete two-manual organ with 24 stops, 12 rotor units are required, occupying a space of about 36 in. × 12 in. × 4 in. A complete organ on these principles takes up not more room than an average pipe organ console. A. W.

***1232. Electronic music.** L. E. C. Hughes. *Nature*, **145**, *pp.* 170-174, *Feb.* 3, 1940.—A general description of a number of electronic musical instruments, with a table indicating the musical and scientific features of those available at the present time. Of recent commercial interest are pianos with electrostatic pick-ups under the wires for straight amplification, thus solving the difficulties of bulk and power. Details are given of the newly released Novachord, in which frequency content, attack, decay, and sustaining are separately controllable ; in this machine the frequencies are obtained by multivibrator division of oscillators conforming to the top chromatic octave. Among pipeless organs, the Orgatron, with electrostatic amplification of frequencies generated by pneumatic reeds, the Electrone, which synthesizes from frequencies generated from electrostatic runners, and the Midgley, which is similar except that the modulation is effected by a rotating dielectric, are important additions to the Hammond, which synthesizes from electromagnetic generators. L. E. C. H.

1233. Dynamics of pianoforte string and hammer. Part III. General theory. M. Ghosh. *Indian Journ. Phys.*, **13**, *pp.* 277–291, *Aug.*, 1939.—The dynamics of the pianoforte string and the elastic hammer has been worked out, following the operational method [see Abstract 1740 (1939)]. Here the method has been extended, to cover the most general case, when the elastic hammer strikes at any point of a string of finite length. This is the exact problem relating to the acoustics of the pianoforte string, and no fruitful attempt was made previously to solve it. The general expressions for the displacement of any point on the string, and the pressure exerted by the hammer during impact, are given. The time-displacement shadowgraph of a point, on the shorter segment of the string was taken by previous workers. It is found that there are smaller kinks, superposed on the hump produced by the impact of the hammer on the string. This is clear evidence of the excitation of vibration in the shorter segment of the string during impact and the theories given by previous workers fail to explain it. Using the data supplied by Banerjee and Ganguli [see Abstract 1940 (1929)], in the theoretical expression of the displacement obtained in this paper, time-displacement curves are drawn. These curves are found to be identical in form and in the number of kinks present with the shadow-graph obtained by the experiments cited above. This shows a remarkable quantitative agreement of the theory with the experiment. Further the values of the duration of contact worked out for some particular cases are found to be in very good agreement with those obtained experimentally. Author.

***1234. Influence of soundboard on piano tone quality.** P. H. Bilhuber and C. A. Johnson. *Acoustical Soc. of America. J.*, **11**, *pp.* 311–320, *Jan.*, 1940.—The main purpose of the soundboard is to amplify the tones of the string. The board is made of quarter-sawed spruce, its shape con-

forming generally to the shape of the piano case, and the grain running from treble to bass. The accessible area of the board was marked off in squares, and the probe of a pick-up could be placed in contact with the centre of each square. The output of the pick-up was coupled to a sound-meter and the effect was measured when a key was struck by a motor-driven striker with controlled speed and force. Maps of the soundboard are made in which the deepness of shade of a given square indicates the percentage of maximum vibrational energy observed. Changes made in structure and mounting include reduction of mass and stiffness by tapering, elimination of buckling strains in mounting, and minimizing adverse strains by equalizing compression at different sections of the bridge. The increased response of the board has resulted in a small increase in the intensity level of the air-borne sound and the duration of tone. G. E. A.

1235. Velocity of sound in air below 0°C. A. E. Bate. *Journ. Sci. Instruments*, **17**, *pp.* 68–69, *March*, 1940.—A method which is suitable for the determination of the velocity of sound at low temperatures is described. The value at −78·5°C. was found to be 283 m./sec. Author.

1236. Supersonic analogy of electromagnetic field. D. Riabouchinsky. *Comptes Rendus*, **209**, *pp.* 664–666, *Nov.* 6, 1939.—Continuing his work on the supersonic analogy of the electromagnetic field [see Abstract 506 (1940)] the author considers the limiting case when the fluid moves with an average velocity approaching infinity. The correspondence between the equations governing the residual wave motion in the fluid and the equations of the electromagnetic field is then perfect. One conclusion drawn is that if there existed an ether in the form of a perfect gas having a density of the order of 10^{12} times that of air, the equations of its wave motion would be formally identical with those of Maxwell. W. S. S.

1237. Supersonic velocities and adiabatic compressibilities of organic liquids. J. Bhimasenachar and K. Venkateswarlu. *Indian Acad. Sci., Proc. Sect. A*, **11**, *pp.* 28–31, *Jan.*, 1940.—Supersonic velocities are reported for 14 organic liquids and the chief constituents of 6 essential oils. All these substances are investigated here for the first time. From these data, the compressibilities are calculated and compared with the compressibilities obtained earlier in some cases by other methods. A brief discussion of the results is given. Authors.

1238. Absorption of supersonic waves in water and in aqueous suspensions. G. K. Hartmann and A. B. Focke. *Phys. Rev.*, **57**, *pp.* 221–225, *Feb.* 1, 1940.—The absorption of supersonic waves in both water and in an aqueous suspension of lycopodium spores was measured at 7 different frequencies ranging from 990 to 2 500 kc./s. in approximately equal steps. A piezoelectric quartz plate was used in each case as a sound source and was driven by an electron-coupled oscillator and 2-stage amplifier capable of yielding 100 W. The radiation pressure of the sound waves against a cone suspended in the field was measured directly with a chainomatic balance. The differences in the absorption coefficients found for lycopodium suspension and for water were compared with the classical theoretical expectation as derived by Sewell. These differences approach more nearly the theoretical value as the frequency increases. This may be due to the relative non-rigidity of the spores at lower frequency—a situation which would violate the theoretical boundary conditions. Authors.

***1239. Measurement of reverberation time with several microphones.** F. Vecchiacchi and M. Nuovo. *Ricerca Scientifica*, **10**, *pp.* 1018–1020, *Nov.*, 1939.—The decay-curves of sound intensity obtained when measuring

the reverberation time of a room show marked irregularities due to variable phase relations of the partial sound-waves. It is usual to counteract this effect by employing a warbling instead of a pure note. Somewhat better results can be achieved by adding the sound intensities in 3 or more different points of the room. For this purpose a separate amplifier and rectifier has to be attached to each of the microphones. In general, the old method is still preferable on account of its greater simplicity. L. E. F.

***1240. Simple apparatus for measurement of reverberation time.** A. Calzà and M. Nuovo. *Ricerca Scientifica*, **10**, *pp.* 1090–1095, *Dec.*, 1939.—An apparatus is described which, while having the main advantages of the double relay types of apparatus [see Abstract 3386 (1939)], is easier to manipulate. L. E. F.

1241. Auditory patterns. H. Fletcher. *Rev. Modern Physics*, **12**, *pp.* 47–65, *Jan.*, 1940.—A cochlear diagram is drawn as a spiral divided into 100 equal parts to indicate nerve positions. On this spiral is drawn an auditory pattern consisting of a shaded area the height of which at any position is proportional to the nerve response at that point. The total loudness corresponds to the total area of the darkened part, and this to the total number of nerve impulses reaching the brain along the auditory nerve. Auditory patterns are shown for pure tones at various intensity levels. The data from which the patterns are drawn are obtained from the masking effect of the sounds. Data are taken from different experiments from which the position co-ordinate of an auditory nerve patch is related to the frequency of the patch. The question of a true loudness scale is investigated. The patterns shown refer to a typical listener with normal hearing. Deafness may be obstructive or due to defective nerve transmission. These may be distinguished by their audiograms. The test in a case of mixed deafness is assisted by taking audiograms by sound conduction through air and through bone. G. E. A.

1242. Use of " warble-tone " in precision audiometry. E. G. Burr. *Roy. Soc. Canada, Trans., Sect. III*, **33**, *pp.* 73–81, *May*, 1939.—The theory of frequency modulation of an e.m.f. wave shows that the voltage at the output of the oscillator will no longer be an alternating e.m.f. of a single frequency but will consist of the original alternating e.m.f. diminished in magnitude and supplemented by alternating e.m.f.s of greater and lesser frequency. The latter form infinite series. The question then arises whether in the pressure of the acoustic field there exists a replica of this spectrum. The author has consequently examined the acoustic field of a warble-tone by the search-tone method, using a specially designed portable beat-frequency oscillator. The effects of interference and phase shifts are studied and the effects of reflection from the chamber boundaries. Fatique effects in the ear are also discussed and some support is given to the belief that the threshold of hearing is more sharply observed with the warble-tone. A. B. W.

***1243. Analysis of low frequencies by light diffraction at capillary waves.** H. E. R. Becker. *Ann. d. Physik*, **36**, 7, *pp.* 585–608, *Dec.*, 1939.—The analysis of l.f. oscillations (of the order $\nu = 100$–$6\,000$ c./s.) by means of the diffraction of light at a mercury surface at which oscillations of the frequencies in question are excited in the form of capillary waves is described. The method is applicable to transitory sound waves lasting for as short a time as 1/25 sec., and to supersonic oscillations. J. S. G. T.

***1244. Portable apparatus for measurement of standard note of musical scale.** A. Barone. *Ricerca Scientifica*, **10**, *pp.* 1021–1024, *Nov.*, 1939.—A description is given of a portable apparatus for measuring the frequency of the normal *la* with a precision of about 0·03%. Such an apparatus is important for use by musicians and singers as well as makers of musical instruments. The apparatus described in this paper has been devised at the National Institute of Electro-Acoustics of the National Council of Research in Italy. The principle of the arrangement is the determination of the exact number of vibrations of a note by comparison, by means of beats, with a standard whose pitch is known. The note taken as a standard for comparison has a frequency of 400 ~ and is furnished by an electric tuning-fork. With this the reference note (*nota d'accordo*), which is supposed variable between 431 and 446 ~, gives a frequency of beats between 31 and 46 ~ which can be measured by a metronome. A diagram giving the general electric arrangement of the apparatus and a photograph of the complete machine as used are contained in the paper. J. J. S.

1245. Musical scale of Highland bagpipe. G. E. Allan. *Phil. Mag.*, **29**, *pp.* 154–161, *Feb.*, 1940.—Frequency tests of the scale intervals for a number of chanters are described. The intervals most out of tune are C/D, F/G′ and G′/A′. Of these the first two are nearly three-quarter tones instead of semitones, and the third interval is on the average too small for a full tone. A graph is made for a new chanter by plotting frequency against distance of mid-hole from reed-tip, and with the knowledge obtained, a chanter was made which was almost in tune with the scale G A B C# D E F# G′ A′, and a scheme was obtained for further improvement of the tuning. G. E. A.

***1246. Radiation of acoustic air-jet generator.** J. Hartmann and F. Lazarus. *Phil. Mag.*, **29**, *pp.* 140–147, *Feb.*, 1940.—The acoustic air-jet generator has previously been described [see Abstract 2747 1931)]. The generator is particularly suitable for the production of waves in the frequency range 10 to 100 kc./s. The intensity of the sound is comparatively very great, corresponding to an energy output of 6 W at 50 kc./s and of about 160 W at 10 kc./s, with an excess pressure of 3·2 kg./cm^2. Recent investigations with a Rayleigh disc have given a formula for the total sound radiation from air-jet generators of this type, but since such measurements are rather complicated, experiments were carried out to see if the total radiation could be measured by observations of the amplitude of the aerial vibrations in the oscillator. It is here shown that these vibrations may be made visible by means of the Riemann mirror formed in front of the oscillator. Projecting this on to a film through a narrow slit, the film being driven at 10 m./s perpendicular to the slit, oscillograms were obtained of the vibrations and from these the intensity could be calculated directly. The results obtained in this way are found to be in fairly good agreement with the Rayleigh disc measurements and are obtained much more readily. [See also Abstract 2956 (1939).] A. W.

1247. Sound. E. G. Richardson. *Phys. Soc., Reports*, **6**, *pp.* 238–269, 1939.

See also Abstracts 976, 1062 and

649B. Tuning fork stabilization. E. Norrman.

653B. Apparatus for improvement of hearing. K. de Boer and R. Vermeulen.

ELECTRICITY AND MAGNETISM.

ALTERNATING-CURRENT NETWORKS.

1248. Calculation of transient phenomena in a.c. circuits. G. Giorgi. *Acad. Lincei, Atti*, **29**, *pp.* 541–542, *May* 20, 1939.—A note pointing out the use of an operator of the form $f(d/dt)/[d/dt \pm jw]$ in the solution of transient problems in a.c. circuits. The function f is the usual operational function characteristic of the circuit. N. F. A.

1249. Impedance networks. R. S. Rivlin. *Phys. Soc., Reports*, **6**, *pp.* 389–402, 1939.

1250. Carey-Foster method of comparing mutual inductance and capacity. E. Tyler. *Phil. Mag.*, **29**, *pp.* 162–168, *Feb.*, 1940.—The note describes 3 simple graphical methods for analysing results obtained with a Carey-Foster circuit used with d.c. In every method families of straight lines are obtained. In two cases the inductance-capacity ratio is obtained from the slope of the lines and the resistance of the secondary winding from an intercept; in the third case this resistance is given by the slope, while the intercept gives the inductance-capacity ratio. N. F. A.

1251. Measurements with ultra-short electric waves on wires. L. Hartshorn. *Phys. Soc., Reports*, **6**, *pp.* 378–388, 1939.

***1252. Balance detectors for a.c. bridges.** N. F. Astbury. *Journ. Sci. Instruments*, **17**, *pp.* 25–32, *Feb.*, 1940.—The article is a review largely devoted to recent developments in devices for detecting balance in a.c. bridge networks. Such devices are, ideally, highly sensitive a.c. voltmeters the response of which is preferably selective as regards phase and frequency of signal. Balanced circuits using either metal rectifiers or thermionic valves form the basis of many useful detectors which possess phase- and frequency-selectivity. A selective detector which uses a cathode-ray tube is mentioned; in this an elliptical trace is made to open or close by one bridge adjustment and is made to tilt by the other. The electron beam indicator (" magic eye ") is also described and its use in detectors is dealt with. Since nearly all these devices require an amplifier preceding them, a brief section is included dealing with certain difficulties associated with the use of amplifiers. Generally speaking, the devices described are not suitable as they stand for frequencies greater than 100 kc./s.: for higher frequencies modulated oscillators or heterodyne amplifiers must be used before the detecting arrangement is applied. N. F. A.

See also Abstracts 1265, 1271 and
456B. Stabilized bridge circuit. H. P. Kalmus.

CONDUCTION AND DISCHARGE IN GASES.

***1253. Mechanical analogy to the motion of electrons in gases.** G. D. Yarnold. *Phil. Mag.*, **29**, *pp.* 47–51, *Jan.*, 1940.—The steady motion of electrons through a gas under the influence of a uniform electric field is represented with a model in which small steel balls are rolled down an inclined plane studded with nails. The motion of the balls down the plane is by no means strictly analogous to that of electrons through a gas but a statistical study of the motion of the balls serves to give a qualitative indication of the trend of drift velocity, velocity of agitation and lateral diffusion with increasing electric force. The velocity distribution of the

balls is deduced from the rolling tests and compares reasonably well with a Maxwellian distribution particularly at the higher velocities, but there are many reasons why the analogy with electron motion would be expected to be imperfect for velocities of agitation greatly exceeding the mean velocity. J. E. K.

1254. Effect of a magnetic force on h.f. discharges in pure gases. A. E. Brown. *Phil. Mag.*, **29**, *pp.* 302–309, *March*, 1940.—In a recent paper [see Abstract 4190 (1938)] on a generalization of the theory of electrical discharges, experiments have been described by Townsend and Gill on the effect of a magnetic force on the h.f. force necessary to start a discharge in a spherical bulb containing dry air. In the present paper an account is given of similar experiments with N_2 and He with the special purification devices employed. The following conclusions previously derived from the theory of oscillatory discharges have now been verified experimentally: (*a*) The force required to start a discharge at high pressures of the gas is independent of the frequency. (*b*) The force required to start a discharge at low pressures increases with the frequency. (*c*) For each frequency there is a small range of values of the magnetic force, in which the magnetic force causes a reduction in the oscillating force necessary to start a discharge in the gas at a low pressure. The reduction is greatest when the relation between the frequency $q/2\pi$ of the force X sin $(qt + \alpha)$ and the magnetic force H is $H = qm/e$, e being the charge and m the mass of the electron. (*d*) The force required to maintain a discharge is considerably less than that required to start it. H. H. Ho.

1255. Positive column of nitrogen arc at amospheric pressure. A. M. Stone and E. S. Lamar. *Phys. Rev.*, **57**, *pp.* 212–220, *Feb.* 1, 1940.—This paper presents an extension of the work described in a previous paper [see Abstract 3391 (1939)] and includes convection as one of the mechanisms by which power is lost from the arc. The theory yields values of the power dissipation per unit length, over the range from 1 to 10 A, and values of the arc temperature, which are in good agreement with existing experimental data. An average radius is computed which shows the same general trends as those exhibited by the visual arc radius as determined from experiment. The present theory provides a satisfactory solution of the arc problem so long as the power loss by radiation constitutes a negligible fraction of the whole. S. A. S.

1256. Striking conditions in a long discharge tube. W. Bartholomeyczyk. *Ann. d. Physik*, **36**, 6, *pp.* 485–520, *Nov.*, 1939.—The starting conditions for a discharge in a long tube are considered from theoretical and experimental points of view. In the experimental work low-pressure He was used in glass tubes from 50 to 100 cm. in length. Particular attention is paid to the effect of a third electrode screening part of the tube wall. The striking begins with a type of corona discharge at the unearthed electrode, and this leads to the formation of a striking cloud in the tube. The main discharge follows when the cloud reaches the potential of the opposite electrode. It is necessary to distinguish between the striking voltage of the cloud and the main striking potential. The pre-discharge which appears when a screening electrode is used is probably a compensating effect for the disturbance of the striking cloud. The more the wall capacity is increased by the screen the more obvious is the pre-discharge. A comprehensive series of measurements of the characteristics of long tube discharges has been made. J. E. R.

1257. H.F. discharge with external electrodes. R. Zouckermann. *Ann. de Physique*, **13**, *pp.* 78–150, *Jan.–Feb.*, 1940.—The author has investigated the potential in a h.f. discharge with external electrodes as function of the pressure in the moment of striking the discharge. The gases under consideration were H_2, N_2, A and Ne. The curves obtained for the potential do not differ from those obtained in ordinary discharges with the exception of the case of H_2. The curves for H_2, N_2 and A have been very accurately determined. Impurities, particularly the presence of traces of Hg, modify the potential considerably. The spectra of the gases under consideration have been studied in the h.f. discharge and are found to undergo great variations in the presence of Hg vapour. L. K.

See also Abstracts 1103, 1106, 1107, 1108, 1109, 1110, 1127, 1182, 1311, 1320.

CONDUCTION IN SOLIDS AND LIQUIDS.

***1258. Generating voltmeter for pressure-insulated h.v. sources.** J. G. Trump, F. J. Safford and R. J. Van de Graaff. *Rev. Sci. Instruments*, **11**, *pp.* 54–56, *Feb.*, 1940.—A description is given of a generating voltmeter suitable for a voltage source insulated by compressed gas. The calibration is linear and the design simple in that neither amplification nor mechanical commutation is required. The paper discusses the principle of operation, the construction, calibration and sensitivity, and tests indicating that the influence of corona on the voltage readings is negligible. Authors.

1259. Variation in electrical conductivity of hydrous crystals with temperature. H. Saegusa and T. Matsumoto. *Tohoku Univ., Sci. Reports*, **28**, *pp.* 235–244, *Oct.*, 1939.—The electrical conductivity of some hydrous crystals such as copper sulphate, calcium sulphate, ferrous sulphate, chrome alum and potassium ferrocyanide has been studied for various temperatures. It was found that the electrical conductivity of these crystals increases with temperature and then decreases anomalously at their dehydration temperatures, and that the electrical conductivity of the hydrous crystals is larger than that of the anhydrides. The variation of the electrical conductivity of these crystals generally follows the formula $\log \sigma = B - A/T$ after the water of crystallization is removed, but in the case of chrome alum it shows some different properties. Suggestions are put forward to explain these experimental results. Authors.

***1260. Crystal detectors.** H. Klumb. *Phys. Zeits.*, **40**, *pp.* 640–643, *Oct.* 15, 1939.—With the object of producing as far as possible the most sensitive and constant crystal detectors for rectification with frequencies of about 10^8 to 10^{11} c./s. investigations were made with a very large number of W-Si detectors to find the sensitiveness and reliable constancy relations. By means of crystal-metal combinations in semi-liquid and plastic substances the known liability to disturbance of the crystal detector was in practice fully overcome and detectors were fashioned which with d.c. service of 1 to 5 mA were capable of employment as rectifiers in the frequency region of 10 to 10^{11} c./s. J. J. S.

1261. Superconductivity. L. C. Jackson. *Phys. Soc., Reports*, **6**, *pp.* 335–344, 1939.

1262. Electrical conductivity of metals. J. Bardeen. *J. of Applied Physics*, **11**, *pp.* 88–111, *Feb.*, 1940.—The author gives illustrative examples of some of the various types of problems connected with the conduction of electricity in metals and alloys and, wherever possible, attempts to correlate them on the basis of the Bloch theory. A Bibliography is appended with 45 references to books and journal articles.

1263. Conductance of solutions of organosubstituted ammonium chlorides in liquid H_2S. E. E. Lineken and J. A. Wilkinson. *Am. Chem. Soc., J.*, **62**, *pp.* 251–256, *Feb.*, 1940.—The conductances of solutions of mono-, di-, tri- and tetrasubstituted methyl-, ethyl- and *n*-propylammonium chlorides in liquid H_2S have been measured. These show that the molecular conductance increases both with the number and the size of the substituted groups, the number having a greater effect than the size. The conductance concentration curves show a minimum which is characteristic of solutions of electrolytes in solvents of low dielectric constant. Authors.

See also Abstracts 941, 955, 1121, 1202, 1300, 1301, 1325 and 455B. Amplifier for d.c. galvanometers. A. W. Sear.

DIELECTRICS AND CAPACITANCE.

1264. Influence of quasicrystalline structure on molecular rotation and relaxation in dipole liquids. E. Fischer and G. Klages. *Phys. Zeits.*, **40**, *pp.* 721–727, *Dec.* 15, 1939.—The relaxation times of pure dipole liquids have been determined by dispersion experiments in the wavelength region 10–150 cm., and the results are compared with the data obtained for dilute solutions. The behaviour of liquids with normal dipole interaction, i.e. approximately spherical molecules, can be described by Debye's theory. Liquids consisting of long-chain molecules (aliphatic chlorides) show peculiarities. The observed shifts of the region of dispersion towards shorter wavelengths can be explained by the formation of a quasicrystalline parallel arrangement of the long molecules. In this case the dipole moments follow the orientation of the electric field by a rotation of the molecules round the longitudinal axis. This explanation holds generally for the relatively small relaxation times of very viscous dipole liquids consisting of long molecules. [See Abstracts 1353 (1939) and 857 (1940).] L. K.

1265. Dielectric constant of water vapour at a frequency of 42 Mc./s. A. C. Tregidga. *Phys. Rev.*, **57**, *pp.* 294—297, *Feb.* 15, 1940.—A heterodyne beat apparatus was constructed for the measurement of the dielectric constant of water vapour, at 42 Mc./s. One of the oscillators was crystal-controlled, the other having a tuned circuit containing a condenser which could be evacuated and filled with water vapour. A cathode-ray oscilloscope was used to indicate zero beat. Drift of the oscillators was eliminated from the results by plotting readings on a time base and alternating between vacuum and water vapour as rapidly as physical limitations would permit. Air was used as the calibration gas, because it is composed of nonpolar molecules. It should therefore have the same dielectric constant at this frequency as at the lower frequencies at which it has been measured by other observers. The Clausius-Mossotti relation was verified for water vapour at constant temperature, and the dielectric constant of water vapour determined at three different temperatures and 760 mm. of mercury. The temperatures in question were 71·9°C., 99·8°C., and 147°C., at which the dielectric constant was found to have the values 1·007 1, 1·006 0. and 1·004 75, respectively. Author.

1266. Dielectric constants of some oxides, hydroxides and oxide-hydrates. O. Glemser. *Zeits. f. Elektrochem.*, **45**, *pp.* 865–870, *Dec.*, 1939.—The author reports the effect on the dielectric constant resulting from progressive dehydration at temperatures up to 1 300°C., for BeO, MgO, Zno, Al_2O_3, Fe_2O_3 in their hydrated forms. Synthetic fine grain

materials show values for ϵ much greater than the natural minerals. This is attributed to greater mobility of the atom groups and the increased shifting-polarization resulting. In the case of the hydrates of FeO abnormally high values for ϵ are probably due to Fe_3O_4 formation.

D. R. H.

1267. Dielectric breakdown in solids. H. Fröhlich. *Phys. Soc., Reports,* **6,** *pp.* 411–430, 1939.

1268. Theory of electric breakdown of crystalline insulators. W. Franz. *Zeits. f. Physik,* **113,** 9–10, *pp.* 607–636, 1939.—Two theories of the electric breakdown are discussed: the "ionization" theory, according to which the breakdown occurs when any free electron that happens to be in the crystal can acquire sufficient energy in the field to produce further free electrons by collision. The "wave-mechanical" theory, which had not been quantitatively discussed before, ascribes the breakdown to the transfer, under the action of the field, of electrons from the highest occupied zone to the conduction band by a kind of "tunnel effect." The calculations in this case are carried out under the assumption that the electrons in the substance are nearly free. The result is that the theoretical field intensity for the wave-mechanical breakdown is of similar order of magnitude to that for ionization breakdown, and varies in a similar way with direction. It shows, however, a much weaker dependence on temperature, and in this respect the experiments seem to favour the "wave-mechanical" explanation. R. P.

1269. Dielectric constant near melting point. R. Guillien. *J. de Physique et le Radium,* **1**, *pp.* 29–33, *Jan.*, 1940.—The dielectric constants of CS_2, C_7H_8, meta–C_8H_{10}, CCl_4, N_2 and H_2 have been determined from temperatures well above the melting point to below it. All show a regular increase and no anomaly as temperature falls to the melting point followed by a sudden rise on solidification; further cooling causes a slight (CS_2 and H_2), or sharp (meta–C_8H_{10}, C_7H_8 and N_2) decrease, while in CCl_4 the change is further complicated by the change from cubic to monoclinic accompanied by a rapid decrease at about $-47{\cdot}6°$. Differences from previous results are explained. C. A. S.

1270. Dielectric loss in polystyrene mixtures. F. C. Frank and W. Jackson. *Faraday Soc., Trans.,* **33,** *pp.* 440–445, *March,* 1939.—The variation of the dielectric loss factor with temperature and frequency of samples of polystyrene containing small percentages of polar compounds is investigated. The results show that the hard polystyrene environment does not impose a severe restriction on the orientation of the polar molecules (butyl phthalate, β-naphthol, chlorinated diphenyl and cetyl palmitate) within it. In the case of cetyl palmitate the loss factor maximum shifts after exposure to a high temperature and it is suggested that this effect is due to a high temperature equilibrium becoming "frozen in" and then subsequently partially released by annealing. The application of the results to dielectric materials of industrial importance is discussed.

A. M. T.

***1271. Measurement of capacitance.** N. F. Astbury. *Phys. Soc., Reports,* **6,** *pp.* 403–410, 1939.

***1272. Use of electrets in electrical instruments.** A. Gemant. *Rev. Sci. Instruments,* **11,** *pp.* 65–71, *Feb.*, 1940.—An electret is a permanently electrically polarized material and exhibits an electric field near its free surface which keeps undiminished for years. It is possible to utilize this

field in electrical appliances. Experiments and devices on this line are described. AUTHOR.

See also Abstracts 997, 998, 1250 and

462B. Measurement of dielectric loss at ultra-high frequencies. K. Morita.

463B. H.f. dielectric-loss measurement by varying-gap method. T. Sakamoto and H. Uno.

ELECTROCHEMISTRY.

1273. Gas cell. Mechanism of electrolysis of water. Polarization of cells. V. KARPEN. *Comptes Rendus*, **209**, *pp.* 988–990, *Dec.* 27, 1939.—The reactions proceeding in the Grove cell are considered from the standpoint of energy. The Grove cell is non-polarizable because H^+ ions travelling to the cathode meet OH^- ions moving in the opposite direction and form H_2O. The e.m.f. of the cell remains constant so long as the pressures of H_2 and O_2 are constant. The polarization of the Leclanché cell is also considered. It is maintained that the reaction providing the energy of the cell is not $Zn + 2NH_4Cl = ZnCl_2 + H_2 + 2NH_3$, but the ionization of O_2 provided by the MnO_2. The O_2 unites with electrons from the electrolyte: $O + 2e + H_2O = 2OH^-$. The OH^- ions meet H^+ ions, as in the Grove cell, before these arrive at the positive pole. This explanation of the process occurring in the Leclanché cell explains why its e.m.f. is 0·6 V greater than that of the voltaic cell. A. J. M.

***1274. Use of zeolitic membrane electrodes.** C. E. MARSHALL. *J. Phys. Chem.*, **43**, *pp.* 1155–1164, *Dec.*, 1939.—Membrane electrodes were prepared from zeolite-like materials by grinding a crystal or cleavage plate with carborundum on a glass plate, until a thickness of about 1 mm. was reached. Chabazite and the closely related gmelinite were found in a crystalline state suitable for the preparation of electrodes. Apophyllite was found to be the most suitable zeolite-like mineral which showed some base-exchange properties. Measurements made with the apophyllite electrodes gave results which were lower than those obtained with the glass electrodes. The difference was considered to be probably caused by the slight attack on the mineral by acid solutions. F. J. B.

1275. Solution potential of cemented iron in acidulated water. S. PROCOPIU. *Comptes Rendus*, **210**, *pp.* 219-221, *Feb.* 5, 1940.—Two cells were used in the determination of the potential, V :—+ Hg | Hg_2 Cl_2 | KCl, aq. satd. | acid, aq. | Fe (cem.) — giving E volt, and + Fe (cem.) | acid, aq. | Fe (pure) — giving e volt. Changes with time of cementation, t, and of solution, T, until V becomes that of pure Fe, indicate that a surface oxidized layer is first removed and then the cemented layer, the thickness, δ, of which, as shown by the loss in weight of the electrode in time T, is represented by Kt, K depending on the temperature of cementation, C°, and increasing therewith, as well as on the time during which cementation continues, thus for $t = 10$ min. and C = 900° $\delta = 125\mu$, and for C = 950° $\delta = 139\mu$, corresponding figures for $t = 20$ are 164 and 259μ. The thickness of the oxidized layer is similarly determined as of the order of 1μ. C. A. S.

See also Abstract 1227 and

424B. Overvoltage. H. Eyring, S. Glasstone and K. J. Laidler.

426B. Electrolyte-chlorine cell. C. Haider.

428B. Cd-Ni storage battery. A. P. Hauel.

429B. Internal electrolysis as a method of analysis. B. L. Clarke and L. A. Wooten.

ELECTRONS, NEUTRONS, POSITRONS AND PROTONS.

1276. Rest-mass of the electron. W. Ruppel. *Ann. d. Physik*, **36**, 6, *pp.* 521–532, *Nov.*, 1939.—The paper contains a theoretical investigation of the difference between observed values of the electronic rest-mass m_0, obtained by experiments with free and bound electrons. This difference leads to a 1% difference between the value of the Rydberg constant obtained by spectroscopy and its theoretical value $2\pi^2e^4m_0/ch^3$, and the author takes the view that this discrepancy is due to the variation of m_0 with the state of binding of the electron. The treatment follows from previous work of O. Scherzer [see Abstract 882 (1940)] ; and the variation of the rest-mass is calculated on the quantum theory of the radiation field. Alternative theoretical variations are either too large or too small, and the experimental variation can be obtained only by artificial extensions of the theory. E. E. W.

1277. Magnetron experiment and e/m ratio for electrons. D. H. Tomboulian and P. L. Hartman. *Am. Phys. Teacher*, **7**, *pp.* 403–405, *Dec.*, 1939.—The experiment now described is based upon that of A. W. Hull [see Abstract 1807 (1921)] and includes the determination of the characteristic curves of a magnetically controlled diode and an evaluation of e/m. It employs standard equipment and such apparatus as can readily be constructed in a laboratory having average facilities. A diagram of the magnetron and associated circuit is included and also one of the cut-off curves obtained. The whole experiment can be carried out in the course of $1\frac{1}{2}$ hr. H. H. Ho.

1278. Quantitative determination of the neutron moment in absolute nuclear magnetons. L. W. Alvarez and F. Bloch. *Phys. Rev.*, **57**, *pp.* 111–122, *Jan.* 15, 1940.—The method, the theory of which is developed in detail, is an extension of the magnetic resonance method of determining nuclear magnetic moments in molecular beams [see Abstract 2090 (1939)]. In place of deflection by inhomogeneous magnetic fields, magnetic scattering is used to produce and analyse the polarized beam of neutrons. The neutron moment μ_n is found directly from the frequency and field when resonance is observed, with the assumption of neutron spin $\frac{1}{2}$. A new method of evaluating the magnetic moment of any nucleus by the resonance method is described ; it may be determined directly in absolute nuclear magnetons by measurement of the ratio of two magnetic fields : (*a*) that at which resonance occurs for a certain frequency, and (*b*) that at which protons are accelerated in a cyclotron operated on the nth harmonic of that frequency. The magnetic moment is then (for $J = \frac{1}{2}$) $\mu = H_b/n H_a$, where n is an integer and H_b/H_a may be determined by null methods. The final value obtained for μ_n is $1{\cdot}93_5 \pm 0{\cdot}02$ absolute nuclear magnetons. N. M. B.

1279. Validity of the X-ray crystal method for determining N and e with Al, Ag, and quartz. P. H. Miller, Jr. and J. W. M. DuMond. *Phys. Rev.*, **57**, *pp.* 198–206, *Feb.* 1, 1940.—Objections to the method arise from the possible presence of a mosaic effect or superstructure and from the X-ray measurement of the lattice constant of only a very superficial layer. The crystal structure of polycrystalline Ag and Al, and of one single crystal, powdered quartz, was precisely measured. The crystallites were small enough for complete penetration by the radiation, and the effect of distortion of the metal crystals on the density and crystal structure was investigated. A comparison of the values found for N and e with

those of Tu [see Abstract 4057 (1932)] and an examination of the effect of distortion indicate that there is perhaps a small mosaic effect that renders the value of N and e uncertain by 0·04% and that the best value of e is $4{\cdot}801 \pm 0{\cdot}002 \times 10^{-10}$ e.s.u., or slightly less than that obtained with macroscopic calcite. N. M. B.

1280. Evaluation of constants e, h, m. C. G. Darwin. *Phys. Soc., Proc.*, **52**, *pp.* 202–209, *March*, 1940.—A recent discussion of the numerical values of the ultimate physical constants e, h, m has been given by Dunnington [see Abstract 3425 (1939)], which exhibits certain small discrepancies. The present work shows a simpler method of discussion than his, which is attained by considering not the quantities themselves but their logarithms. Author.

***1281. Rotating sector in electron-diffraction photographs.** F. Trendelenburg. *Phys. Zeits.*, **40**, *pp.* 727–728, *Dec.* 15, 1939.—Short discussion of the advantages of the use of a rotating sector in electron-diffraction photographs either in the electron-diffraction chamber itself or at the subsequent copying process. [See Abstract 4146 (1939).] L. K.

1282. Neutron-proton scattering cross-section. L. Simons. *K. Danske Vidensk. Selskab.*, **17**, 7, [16 *pp.*], 1940. *In English.*—The mean free path and hence the cross-section has been accurately determined by measuring the activities produced in a detector by neutrons before and after transmission through a scatterer consisting of water in a glass container. The neutron source was Ra + Be in paraffin wax and a " resonance filter " was introduced between source and scatterer of the same material as the detector, so selecting the neutrons of resonant energy and utilizing the fact that the scattered neutrons have suffered energy loss and are consequently not detected. The detectors used which were placed in a pocket of Cd sheet were Ag and I and their activities after exposure were measured by a large Geiger-Müller counter filled with alcohol and A. Results with different detectors, water thicknesses and source-detector distances agreed within statistical error. The mean free path of the resonant neutrons in water was 0·91 cm. from which a neutron-proton cross-section of $14{\cdot}8 \times 10^{-24}$ cm^2. was calculated. Using this value agreement is obtained between experimental data and Wigner's formula for the cross-section. J. B. W.

1283. Proton scattering. A. S. Eddington and H. M. Thaxton. *Physica*, **7**, *pp.* 122–124, *Feb.*, 1940. *In English.*—Experimental values [see Abstract 3011 (1939)] for the range and depth of the nuclear interaction potential do not agree with the earlier theoretical values of Eddington [see Abstract 4241 (1937)]. Alteration of k_0 by a factor of $\sqrt{3/4}$ and m_0 by $\sqrt{4/3}$ produces good agreement with the experimental results. Several suggestions are given as to the origin of the factor 4/3. G. O. B.

1284. p-Wave anomalies in proton-proton scattering. G. Breit, C. Kittel and H. M. Thaxton. *Phys. Rev.*, **57**, *pp.* 255–259, *Feb.* 15, 1940. —The p-wave effects on Bethe's neutral form of meson theory are calculated for proton energies of 2·0, 2·4 and 3·0 eMV. The range of nuclear force corresponding to a meson mass of 180 electron masses gives effects of the order of a few per cent of the total scattering. These effects do not vanish at the scattering angle of 45°. If present, they call for a slight increase in the range of force derived from s scattering. The

comparison of the theoretical and experimental angular distributions indicates, however, that p-wave effects predicted by the above meson theory with a mass of 180 m are too large since they give too much small angle scattering. [See also Abstract 3012 (1939).] AUTHORS.

1285. Multiple scattering of fast electrons. C. W. SHEPPARD AND W. A. FOWLER. *Phys. Rev.*, **57**, *pp.* 273-280, *Feb.* 15, 1940.—The scattering of electrons and positrons of energy from 5 to 17 eMV has been measured in lead foils of thickness 0·015 and 0·038 cm., in C laminæ of thickness 0·132 and 0·381 cm., and in an Al foil of thickness 0·118 cm. The scattering has been shown to be in agreement with the multiple scattering theory of Williams in that the distribution in the product of the scattering angle times the energy of the scattered particle is Gaussian in form, and in that the mean scattering angle times energy is independent of certain geometrical aspects of the experimental method of measurement, and of the energy and sign of charge of the scattered particles. For C the experimental magnitude of the mean scattering is in satisfactory agreement with theory, but in Al and Pb the experimental results are only 85% and 60% respectively, of the theoretical predictions. AUTHORS.

1286. Behaviour of slow neutrons in water and paraffin. A. BOUWERS. *Physica*, **7**, *pp.* 193–198, *March*, 1940. *In English.*—The yield of a powerful neutron source may be measured in a simple way by means of a very thin detector of slow neutrons placed in a hydrogenated substance surrounding the source. Some of the quantities used in the calculations are discussed in this paper, such as the average path $\bar{\delta}$ of a neutron in the thin detector and the average number N of collisions before capture. The discussion of the latter quantity leads to the question of the reflection coefficient β (albedo) of a plane boundary. The value of β is found by elementary considerations. [See following Abstract.] AUTHOR.

1287. Albedo of hydrogenated substance for slow neutrons. W. DE GROOT AND K. F. NIESSEN. *Physica*, **7**, *pp.* 199–204, *March*, 1940. *In English.*—In the formula $\beta = 1 - (4/\sqrt{3})\,(1/\sqrt{N})$, found by Halpern and co-workers [see Abstract 866 (1938)] for the albedo, the next term is calculated, thus giving $\beta = 1 - (4/\sqrt{3})\,(1/\sqrt{N}) + 2{\cdot}86/N$. [See preceding Abstract.]

1288. Total secondary electron emission from polycrystalline Ni, NaCl and KCl. H. SAEGUSA AND T. MATSUMOTO. *Tohoku Univ., Sci. Reports*, **28**, *pp.* 245–260, *Oct.*, 1939.—Total secondary electron emission from polycrystalline Ni and evaporated films of NaCl and KCl has been studied in a range of low voltages. It was found that several peaks in the secondary electron emission appear in polycrystalline Ni and that they coincide well with R. Rao's result. Two peaks in the secondary electron emission were found in NaCl film at 14 and 23 V. In the case of KCl film, one peak was distinctly found at about 7 V. These results were compared with Hilsch-Pohl's results for absorption of alkali halide, and it was found that there were similarities between them. AUTHORS.

***1289. New supermicroscope and its application in bacteriology.** E. BRÜCHE AND E. HAAGEN. *Naturwiss.*, **27**, *pp.* 809–811, *Dec.* 8, 1939.—An electrostatic electron microscope is described consisting of a 2-stage arrangement of short focal length symmetrical electrostatic lenses which have 2 outer electrodes at anode potential and a central electrode at cathode

potential. With an accelerating potential of 50 kV a total magnification of 5 000 is obtained. Photographs are given of a number of bacilli and of a spirochete, from which it is estimated that the resolving limit of the microscope is approximately $0{\cdot}1\ \mu$. H. J. H. S.

See also Abstracts 922, 926, 985, 1010, 1127, 1128, 1136 and

466B. Wider applications of the cathode-ray oscillograph due to new accessories. F. Bruchmann.

468B. Limit of magnification by a magnetic lens for electron microscope. E. Sugata.

469B. Electron optics of cylindrical electric and magnetic fields. A. Rose.

ELECTROSTATICS.

1290. Contact p.d. between Ba and Zn. External work function of Zn. P. A. Anderson. *Phys. Rev.*, **57**, *pp.* 122–127, *Jan.* 15, 1940.—Methods previously reported [see Abstract 5058 (1938)] are extended to Zn with reference to Ba. Measurement was by the retarding potential method with variable anode, in tubes sealed from the pumps and gettered with vaporized Ba. In observations on 3 tubes and 15 pairs of Ba-Zn surfaces the observed contact p.d., mean value $1{\cdot}76$ V, was reproducible and constant to $\pm\ 0{\cdot}02$ V. Combination of this value with the Ba work function $2{\cdot}52$ eV gives $4{\cdot}28 \pm 0{\cdot}02$ eV for the work function of Zn at room temperature. Evidence is given to show that the work function measured under optimum vacuum conditions is characteristic of clean Zn, and not of a gas-contaminated surface in equilibrium with the residual gas. N. M. B.

1291. Electrostatic purification of lubricating oil. D. Avsec. *Comptes Rendus*, **209**, *pp.* 830–832, *Dec.* 4, 1939.—Continuing former experiments the author has found a purifying effect to occur when a pointed electrode is placed above a layer of oil containing matter in suspension (e.g. Shell Oil B 14 which is very viscous and almost black). On allowing some of the oil to drop upon a glass plate the oil spreads over the surface thus becoming thinner and takes a circular form. In the experiment described the thickness and final diameter of the oil layer were $0{\cdot}285$ mm. and 96 mm. repectively. When a pointed electrode is brought above the oil sheet at a tension of the order of 50 000 V, electro-convective instantaneous whirlpools are seen to occur. At the moment of applying the tension the layer spreads and the lessening of thickness which thus occurs is due first to the electro-convective wind from the point, and next to Maxwell's electric tensions. At the same time the central region of the layer becomes clearer, the particles in suspension being chased to the periphery of the sheet of oil. The particles so driven are electrically charged. When the tension is removed they spread throughout the oil. When an earthed metal plate is used instead of glass similar whirlpools occur and these disappear on interposing various objects between the electrified point and the oil. In this way an electro-convective shadow of the object may be obtained. J. J. S.

1292. Fleming's method of electrification and Coehn's electrostatic experiments. R. Schnurmann. *Phys. Soc., Proc.*, **52**, *pp.* 179–183. *March*, 1940.—Silica flour poured from a glass beaker or a copper trough carries negative charges away. The silica particles acquire these charges while in contact with glass or copper walls at room temperature. With the sole exception of what is known as "waterfall electrification", cases of electrification through friction or through impact are in fact cases of contact electrification. The sign of the charges separated depends on the work function and the solution pressure of the metal with respect to the

dielectric. The action of rubbing an insulator against a metal, for instance, silica in bulk against copper in bulk, can lead to an inversion of the sign of the static charges acquired; the silica can assume a positive charge. This is ascribed to the dependence upon temperature of the migration of positive ions from the metal to the insulator. The action of rubbing thus has two functions: firstly, it helps to establish intimate contact between two solids, and secondly, in the atmosphere it abrades particles from noble metals. In addition, in the case of less noble metals the rise of temperature of the surface irregularities increases the ability of the surface of the dielectric to accept positive ions. [See Abstracts 375 (1922), 456 (1925) and 2632 (1939).] AUTHOR.

GALVANOMAGNETIC AND THERMOMAGNETIC EFFECTS.

See Abstracts 1200, 1201, 1294, and

475B. Resistance change of thin Bi films in magnetic fields. Z. Yamaguti.

MAGNETISM AND ELECTROMAGNETISM.

1293. Magnetic viscosity of single crystals of iron. T. NISHINA. *Tohoku Univ., Sci. Reports*, **28**, *pp.* 217–224, *Oct.*, 1939. *Report No.* 463 *of the Research Inst. for Iron, Steel and other Metals.*—The present investigation was made to determine the magnetic viscosity in cylindrical rods of single crystal of iron by the magnetometric method at the temperature of liquid N_2, namely, at $-195{\cdot}7°$. The axes of these rods were made almost to coincide with the direction of the principal axes of the crystal, namely, [100], [110] and [111]. To find the relation between the magnetic field and the magnetic viscosity, the intensity of the external magnetic field was varied; in the case of the [111]-rod the magnetic viscosity was measured with two rods of different diameters. AUTHOR.

1294. Effect of special heat-treatment on magnetic permeability of Ni-Fe alloys. T. NISHINA. *Tohoku Univ., Sci. Reports*, **28**, *pp.* 225–234, *Oct.*, 1939. *Report No.* 464 *of the Research Inst. for Iron, Steel and other Metals.*—A study by the ballistic method was made of wires of 6 Ni-Fe alloys containing 50, 65, 75, 80, 85, and 90% Ni, 25 cm. long and 1 mm. in dia. which were firstly heated at 600° and then subjected to tensions, cooled slowly to room temperature and the tension removed. By this treatment it was found that in an alloy having a positive magnetostriction, such as 65% Ni alloy, the permeability in a weak magnetic field increases remarkably for a proper amount of tension, but in the case of an alloy having a negative magnetostriction, such as 90% Ni alloy, it decreases by the same treatment. The results obtained are explained by a thermodynamical relation. AUTHOR.

***1295. Differential apparatus for detecting and determining the permeability of small specimens of substances at medium frequencies, with an amplifier.** A. COLOMBANI. *Comptes Rendus*, **210**, *pp.* 47–48, *Jan.* 3, 1940.—An apparatus for determining the permeability of small samples of substances, depending on the variation of the induction between coils with and without the sample, is described. The method has been applied to the determination of the permeability of a film of Ni obtained by cathodic sputtering in H_2. A. J. M.

1296. Paramagnetic dispersion. P. TEUNISSEN AND C. J. GORTER. *Physica*, **7**, *pp.* 33–44, *Jan.*, 1940. *In English.*—Detailed results of a series of researches on paramagnetic dispersion in salts of the iron group.

This effect is found in the highly hydrated vanadous, chromic, manganous and ferric salts which contain either 21 or 23 electrons per ion. Solutions of manganic salts do not produce the effect. The results are discussed. [See Abstract 560 (1940).] G. E. A.

1297. Theory of paramagnetic relaxation. L. S. Ornstein. *Physica*, **7**, *pp.* 205–207, *March*, 1940. *In English.*—The author discusses the common basis of the theories of paramagnetic relaxation given by Gorter and Kronig on the one hand, and Dupré and Casimir on the other. [See Abstract 3855 (1938).] Author.

1298. Magnetic susceptibility of silver sub-fluoride. S. Freed, N. Sugarman and R. P. Metcalf. *J. Chem. Phys.*, **8**, *pp.* 225–226, *Feb.*, 1940.—The metallic character of the crystals of Ag_2F was studied in terms of the magnetic susceptibility. It was found that the conduction electrons contributed a considerable diamagnetism which is related especially to the anisotropy of the crystals. Authors.

***1299. Production of annular magnetic fields of great uniformity.** M. Ference, A. E. Shaw and R. J. Stephenson. *Rev. Sci. Instruments*, **11**, *pp.* 57–62, *Feb.*, 1940.—In the magnetic focusing of electron or ion beams, it is important to secure magnetic fields which possess homogeneity over the region in space traversed by the beam. Helmholtz coils, frequently used for this purpose, provide the desired uniformity of field only for a limited region coaxial with the coils, but for regions off the axis in the median plane, the magnetic field is not uniform. It has been shown theoretically and verified experimentally that in order to obtain the necessary uniformity off the axis in the median plane, the axial separation of the coils must be diminished ; this separation depends upon the region in which the uniformity is desired. A pair of coils whose separation may be varied has been constructed of mean radius 30·712 cm., each having 900 turns and an approximate square cross-section of windings of side 6·856 cm. The field due to the coils has been explored off the axis in the median plane using a standard coil and magnetometer. The measurements reveal that the uniformity produced with the new separation is vastly superior to that which results from the usual Helmholtz separation. Authors.

1300. Sphere in a uniform alternating magnetic or electric field. M. Divilkovskij. *J. Techn. Physics, U.S.S.R.*, **9**, 5, *pp.* 433–443, 1939. *In Russian.*—A calculation is given of the electromagnetic field inside and outside a sphere placed in an originally uniform alternating magnetic or electric field. Formulae are deduced for the power absorbed by the sphere, and for the induced magnetic and electric moment. It is shown that the power losses in polar dielectric liquids and electrolytes in an alternating magnetic field become appreciable in the region of decimetre waves. Curves showing the power loss as a function of frequency are given both in the magnetic and electric cases for a number of substances. D. S.

***1301. Variably astatic magnetic system.** J. Tagger. *Phys. Zeits.*, **40**, *pp.* 718–721, *Dec.* 15, 1939.—A variably astatic system for a Paschen galvanometer is described, consisting of a horse-shoe magnet whose curved end has been cut off. The two pole ends are kept in position by rigid connecting pieces through which a screw spindle is led. A nut moving on the spindle is used for varying the astasation of the system. If the magnetic axes of the magnets lie in a plane with the rotational axis, but diverge from the iron nut, the system can be made completely astatic.

The sensitivity of a galvanometer varies in the ratio 1 : 50 if the position of the nut is varied from the anastatic position to complete astatisation. L. K.

See also Abstracts 955, 1236, 1250.

MEDICAL RADIOLOGY AND ELECTROLOGY.

***1302. Collective fluorography.** M. DE ABREU. *Radiology*, **33**, *pp.* 363–371, *Sept.*, 1939.—A description of the fluorographic apparatus installed at the German Hospital in Rio de Janeiro in 1936 for the purpose of carrying out a collective thoracic survey [see also Abstract 452 (1939)]. The technique used was as follows :—4 valve rectified apparatus, water-cooled 10 kW line focus X-ray tube, G. E. Patterson or Siemens' Super Astral screen without yellow varnish, Zeiss objective f/1·5 used with an objective screen distance of 90 cm., and an X-ray tube-screen distance 60 cm. The films found suitable were Kodak Super XX film (32 Sch.) or Agfa Isopan I.S.S. (31 Sch.). The exposure times with an average adult chest were from 0·2–0·3 sec. at 50 mA and 55 kV and for children from 0·03–0·05 sec. at 100 mA and 50 kV. If half-wave apparatus is used without rectification then 70 kV is recommended leaving the other factors unchanged. The 35 mm. film size is preferred because it is easily available and inexpensive. The small image 2·4 cm. square has a perfection of detail completely adequate for a diagnostic survey. Teleradiography and planigraphy must often be used as supplements for an individual case. A comparison is made of the expense of the 3 methods for the examination of 1 million subjects annually, radiography $900 000, radioscopy $340 000 and röntgen photography $112 000. The author considers that it is erroneous to believe that the greater detail obtainable with instantaneous teleradiography permits a finer diagnosis of tuberculosis. The limit of visibility of pulmonary lesions indicates that such visibility is mainly determined by radiogeometry i.e. by the angle of incidence of the radiation on surfaces bounding different densities. If the incidence on the surface of the lesion is parallel the visibility is clear ; if, however, it is oblique or transverse with an obliquity greater than 22·5°, the images are faint or may even vanish. Thus, in the best teleradiography, processes having a volume from 20–100 cm^3. are not visible. Under these conditions it is considered that frequent röntgen photography at various angles such as anterior and posterior descending directions has the advantage over teleradiography of showing faintly visible or invisible lesions. T. A. C.

***1303. Fluorography. Photography of the fluorescent image.** I. S. HIRSCH. *Am. J. of Roentgenology and Radium Therapy*, **43**, *pp.* 45–52, *Jan.*, 1940.—Attempts to photograph the fluorescent X-ray image began very shortly after the discovery of X-rays. The history of the subject is described and, of recent years, progress has been possible owing to the improvement of fluorescent screens by Levy of London. The author describes an apparatus he has used, following investigations by de Abreau. The advantage of the method is that, only small films being used in the camera, of size 2″ × 2″, the cost of routine examination is rendered negligible as compared with the cost of 14″ × 17″ X-ray films, as generally used. It can be utilized in bone, alimentary tract and heart work, but its greatest field of usefulness is in respect to the lungs. B. J. L.

***1304. Fluororoentgenograph.** F. J. LUST. *Am. J. of Roentgenology and Radium Therapy*, **43**, *pp.* 141–142, *Jan.*, 1940.—Describes an apparatus to permit rapid production of X-ray films of any part of the body during screen examination. Many previous investigators have developed

apparatus in this respect but the accessory apparatus in the present form can be used in any position, is simple in construction, and can be manufactured by any skilled mechanic. The part of the body to be radiographed is visible immediately before radiography and the rotating cassette, allowing 4 film exposures, is built into the apparatus. B. J. L.

1305. Soft-tissue radiography. M. NEWEY. *Radiography*, **6**, *pp.* 29–40, *Feb.*, 1940.—The term " soft-tissue " radiography in its widest application, includes the radiography of any parts of the body not included in the skeletal framework. This may further be divided into 2 sections : radiography of the neck and extremities, and radiography of the organs or ductless glands of the trunk. Some typical radiographs are illustrated taken with a small unrectified current unit with a 6 kW self-protected tube at 55–57 kVp with 45–50 mA and exposures with the grid of 1 sec. or less at a distance of 30". Details of the technique are discussed ; a Potter-Bucky diaphragm or Lysholm grid considerably reduces the amount of scattered radiation reaching the film, a Pb sheet beneath the film absorbs any radiation scattered back from the couch, a cone, to help confine the primary beam and reduce the field of scatter is also a great asset. Intensifying screens must be used with a grid, otherwise the exposure becomes unreasonably long. Apart from that they increase contrast and should therefore be used for all parts where the total density is great. They should not be used for less dense parts, as in this case they produce too much contrast. The speed of intensifying screens varies and the slow screens produce less contrast but more detail in the negative than in the high speed ones. Two distinct types of film emulsion are made, for use with screen and without. The latter are particularly suitable for radiography of the extremities and face as they give the maximum amount of detail and contrast. The developer must be kept fresh and at the correct temperature otherwise contrast will suffer. As the developer deteriorates the bromide content increases and the process of oxidation progresses which together have the effect of slowing up the action of the developer and so reducing film contrast. T. A. C.

***1306. X-ray tubes for voltages up to one million.** A. BOUWERS AND J. H. VAN DER TUUK. *Brit. J. of Radiology*, **12**, *pp.* 658–666, *Dec.*, 1939. —Recent modifications of a previously described sealed off, h.v. X-ray tube are described [see Abstract 4391 (1936)]. The new tube has three sections and is designed for voltages up to a million. The X-ray output at 1 m. focal distance perpendicular to the electron beam, using 800 kV constant potential is about 14 r./min./mA. With increased filtration half-value layers up to 10·3 mm. Cu and 4·2 mm. Pb were obtained. Using 500 kV and 800 kV a large number of measurements of back scatter, depth dose and emergent dose in a water phantom, were made, the results agreeing well with those of previous observers. Radiation protection measurements show that at 1 000 kV and 1 mA approximately 9 cm. Pb are required to reduce the primary beam at 1 m. to the tolerance dose rate (10^{-5} r./sec.). Scattered radiation, however, from a phantom was found to be much more easily absorbed. Measurements of the spatial distribution of radiation round the target show that the X-ray output in the direction of the electron beam is almost 3 times that in the perpendicular direction. The quality, however, was almost unchanged. J. E. R.

***1307. Production and measurement of short-wave radiations.** G. W. C. KAYE, G. E. BELL, W. BINKS AND W. E. PERRY. *Phys. Soc., Reports*, **6**, *pp.* 95–124, 1939.

1308. Physical factors influencing the difference between 200- and 500-kV radiation. K. E. Corrigan. *Radiology*, **34**, *pp.* 8–12, *Jan.*, 1940. —An analysis of the effects of 200-kV and 500-kV radiation. Preliminary considerations led to the conclusion that the numerically increased depth dose at 500 kV was unlikely to account for the increased therapeutic results, and that the results would be due rather to added Compton electrons and high-energy photo-electrons at the higher voltage. Experiments were carried out on a phantom and these conclusions were generally confirmed, including the fact that the increase is also due to the higher proportion of short-wave radiation, rather than to its numerical value. E. H. W. B.

1309. Differences between 200-kV and supervoltage roentgen therapy. R. Dresser, J. C. Rude and B. J. Cosman. *Radiology*, **34**, *pp.* 13–16, *Jan.*, 1940.—Therapeutic results are compared, using 200 kV from normal apparatus and 1-MV radiation from a Van de Graaff electrostatic generator. The increased therapeutic results due to the latter are ascribed to the greater penetration and the reduced back-scattering. The complete results include also—less skin damage; less general reaction of the patient and a greater depth dose. Whilst for 200 kV radiation $\frac{1}{4}$in. of lead is sufficient protection, at 1 MV 6 in. is required. E. H. W. B.

1310. Biological measurement of h.v. radiations. C. Packard. *Radiology*, **34**, *pp.* 17–23, *Jan.*, 1940.—Evidence is put forward that the quantitative effects of very short wave radiations, the doses of which are measured by the usually available dosimeters, do not conform with expectations based on experience with low kilovoltages. A biological unit is therefore suggested, the test object being the Drosophila egg. Measurement with X-rays generated at or below 200 kV show that a measured dose of 190 *r*. always produces a 50% death rate in the eggs. On this basis it is shown that the intensity of X-ray beams produced at 400 kV and higher, measured by the biological method is approximately 20% lower than the intensity registered by a Victoreen dosemeter. Further measurements have been made of back-scatter and percentage depth dose by the biological method. J. E. R.

***1311. Spanish standard for the roentgen.** H. T. Plasencia. *Radiology*, **34**, *pp.* 82–94, *Jan.*, 1940.—A standard ionization chamber system for the absolute measurement of X-rays has been set up in the laboratory for Radiological Measurements attached to the Service of Physical Therapy. The author describes the apparatus in detail and gives an account of the investigation and correction of errors. An outstanding feature of the apparatus is the piezo-electric crystal which is used for the absolute measurement of charge. Measurements have been made with a series of X-ray qualities, produced at 60 to 180 kV. It is hoped eventually to compare the apparatus with other national standards. J. E. R.

1312. Relative response of the skin of mice to X- and γ-rays. J. C. Mottram and L. H. Gray. *Brit. J. of Radiology*, **13**, *pp.* 31–34, *Jan.*, 1940.—The majority of clinicians are of the opinion that the skin shows a differential response to radiation according to wavelength but as Ra treatments are usually given at a much lower intensity than X-ray treatment the result may be obscured by the uncertain influence of the time factor. In these experiments, short lengths of the tails of mice were irradiated with X- and γ-rays so that the dose received was the same at all points throughout the irradiated portion of the tail and in all cases care was taken to keep the duration of irradiation so similar that variation in the time factor played no part in the results obtained. When thus irradiated with equal

doses of X- and γ-rays measured in röntgens, the skin reactions were found to be markedly different. The ratio of effectiveness for erythema and desquamation was 1·3 and for epilation and exudation 1·6, the X-rays having the greater effect. Although the dose of radiation delivered throughout the whole of the irradiated portion of the tail was constant for both X- and γ-rays, it does not follow that the amounts of energy released were identical. In the case of both qualities of X-rays used at 117 kV and 190 kV, elements of high atomic number such as S and Ca give rise to a high photo-electric emission, which represents an additional contribution to the energy released in the immediate vicinity of these elements. Consideration was given to the presence of S in the skin and Ca in the bones of the tail and although it was not possible to account completely for the differences found it seems that the photo-electric absorption partly explains the differences observed biologically. The authors hesitate to conclude from the present experiments that these differences are conditioned by wavelength, except in so far as wavelength may determine the energy released in the cell through the process of photoelectric absorption. T. A. C.

1313. Two years' experience with 400kV constant potential deep therapy. D. Steel. *Radiology*, **34,** *pp.* 187–192, *Feb.*, 1940.—The apparatus used consisted of a 400 kV constan potential generator with a Coolidge tube having a built-in filter of 2 mm. Cu. A Thoraeus filter was added (0·93 mm. Sn + 0·27 mm. Cu) plus bakelite and an ionometer chamber giving a filter having the equivalent of 6·5 mm. Cu. The apparatus has been operated at 400 kV constant potential, 5 mA and 80 cm. distance. Under such conditions the H.V.L. was 5·4 mm. Cu and the intensity 14 r./min. The daily dosage was low, seldom over 140 r. to any field. The fields were arranged: one, to cross-fire the lesion wherever possible, and two, to give daily dosage to the tumour without using the same fields or fields each day. This idea was worked out on all the common sites; in the pelvic cases, e.g. by using two fields front and two fields back. Recent trends in therapy favour heavier filtration and even though further investigation might well prove that beyond a certain point added filtration is of no clinical benefit, it seems that at present the heaviest filtration consistent with an economical r output is advisable. The skin reaction which has heretofore been the barrier, subsides more quickly than with lower voltage, lower filtration radiation given in more or less massive doses. Some cases are described in which the total dose to each field is brought as near as possible to 3 000 r. measured in air. In several cases 3 500 r. has been reached. A skin reaction always results, but it is surprising how minimal and how short is its duration. The author feels justified in saying that as the result of two years' experience, that the higher voltage with the use of greater filtration resulting in a shorter wavelength, when used with the protracted method, is a great step forward and has come to stay. T. A. C.

1314. Therapeutic and economic indications for teleradium and the supervoltage X-ray machine. C. Def. Lucas. *Radiology*, **34,** *pp.* 193–199, *Feb.*, 1940.—The qualities of rays obtained from the 200 kV X-ray machine, the 700 kV X-ray machine, and the Ra element pack are compared from a standpoint of depth dosage, cellular selectivity, and the production of threshold skin erythema. The depth dosage curves for certain standard set-ups are shown and the small percentage of difference between the quality of the three rays is demonstrated. The rates of destruction and recuperation of normal and neoplastic tissues, with the possible valuable combinations, are shown. The economics of the set-ups is discussed and detailed

tables showing the number of annual treatments required for tumours of various body locations, their cost per treatment and per case, the number of machines required, and their cost of installation and upkeep are presented. Conclusions as to the value of the supervoltage equipment and teleradium are drawn. The physical measurements for the 700 kV X-ray machine and Ra element pack were obtained from publications of the Physics Department of the Memorial Hospital, New York City. Other calculations were made by the author from the many standard works on the various subjects. AUTHOR.

***1315. Electrical protective devices in radium work.** J. DE MENT. *Am. J. of Roentgenology and Radium Therapy*, **42**, *pp.* 930–933, *Dec.*, 1939.—The protection of operatives engaged in handling Ra for medical and other purposes is discussed in respect to the α, β, and γ rays. The α- and β-rays are modified, unlike the γ-rays, by an electrical field. To protect the operator he works between plate electrodes of large size, across which is a p.d. maintained by a transformer or induction coil. Magnets displace the beams of α- and β-rays so that they do not impinge upon the operator, i.e. they can be deviated to go in any direction away from the operator by suitable adjustments of magnetic and electrostatic fields. The γ-rays are not affected, for which usual protective measures are necessary. The method should also be applicable to work with protons, positrons and barytrons. B. J. L.

1316. Biological applications of neutrons and artificial radioactivity. J. H. LAWRENCE. *Nature*, **145**, *pp.* 125–127, *Jan.* 27, 1940.—A short account is given of some of the investigations carried out in the Radiation Laboratory of the University of California with the aid of the new 60-in. cyclotron. Most of the contributions of nuclear physics to the problems of biology up to the present day are in the uses of " tagged " radioactive isotopes. These have been used over a wide range of botanical, zoological, and in some cases clinical, problems. Increasing use is, however, being made of neutrons and artificial radioactivity in cancer therapy. J. E. R.

1317. Production of radioactive substances and neutron rays. F. N. D. KURIE. *Am. J. of Roentgenology and Radium Therapy*, **43**, *pp.* 107–112, *Jan.*, 1940.—The author gives a very easily understood account of recent developments concerning the structure of atoms, which are being utilized in practical radiation therapy. Neutrons having no charge are very penetrating as they are not attracted by the electrons of the atoms of the medium. On impact with another atom they are slowed down, the impact being of a bouncing type and, biologically, the radiation is very destructive and hence can be of therapeutic value. The production of neutrons and the transmutations of various elements, for example N and He to O and H, and of Al and He to P and a neutron and other transmutations are described. The most convenient method of producing neutrons is by electrical means and a description of the " cyclotron " with which electrons are accelerated by a h.f. field in a strong electromagnetic field is given. Such apparatus has been built to give electron velocities of 10^7 V and others are under construction for velocities between $1{\cdot}5$ and $2{\cdot}5 \times 10^7$ V, which will economically displace Ra γ-radiation. A further mode of production of neutrons is the bombardment of Be with swift deuterons. B. J. L.

1318. Report of the Research and Standardization Committee of the American Radium Society. *Am. J. of Roentgenology and Radium Therapy*, **43**, *pp.* 118–126, *Jan.*, 1940.—A report is made by a Committee

formed in 1937 to correlate methods in use for Ra and Rn therapy. The factors which have been considered are the amount of Ra or Rn, time of exposure, kind and thickness of filter used, the surface area of irradiation, distance of the applicator, dimensions of the radiated mass of tissue and approximate distribution of radiation within the tissues. The collected data are given in tabular form. B. J. L.

***1319. Radium quantity meter.** R. B. TAFT. *Am. J. of Roentgenology and Radium Therapy*, **42**, *pp.* 900–902, *Dec.*, 1939.—An apparatus is described for rapid determination, with fair accuracy, of the amount of Ra in Ra packs, bandages, etc. The apparatus consists of a pair of ionization chambers, the balanced currents from which are varied according to the amount of Ra and recorded by a thermionic valve and microammeter, with two scales according to the amount of Ra which may come into question. B. J. L.

***1320. Therapy with high-speed electrons.** R. SCHINDLER. *Radiology*, **34**, *pp.* 222–234, *Feb.*, 1940.—A detailed survey is made of the present position in the production and therapeutic possibilities of cathode rays generated at from 1 to 5 mV. An impulse generator for 2·4 MV, used by the author, is described. Qualitatively the actions of electrons and X-rays are nearly identical, but there are quantitative differences due to their different spatial distribution of ionization. The chief feature of the ionization distribution in tissues irradiated by electrons, is the increase in ionization during the later part of the range. It is thus possible to deliver a greater dose to a deep point than is received by the overlying material. The fixed range of the electrons has also some therapeutic advantages. With the kilovoltages now available only comparatively superficial treatments are possible, though attempts have been made to irradiate deeper tissues through a hollow needle. For more extensive deep therapy 20 MV or more will be required. The advantages of high-speed electrons for the treatment of malignant disease are summarized. J. E. R.

See also Abstracts 1097, 1198.

OSCILLATIONS AND WAVES.

***1321. Mercury-vapour rectifier.** A. J. ALLEN AND A. G. NESTER. *Rev. Sci. Instruments*, **11**, *pp.* 43–44, *Jan.*, 1940.—A rectifier mounted in a pyrex bulb has been developed for use in the oscillator anode supply of a cyclotron. It takes a filament current of 40 A at 1·6 V and can give an output of 4 A at 10 000 V in a 3-phase full-wave rectifier circuit. The filament is made from a double thickness of Ni wire mesh 5·5 in. by 0·875 in., wound into a spiral and spot welded to 0·125 in. W leads sealed into nonex glass. The filament may be coated with a mixture of strontium and barium carbonate with a little graphite added or with a proprietary mixture. There is a cathode shield connected to the central cathode lead; it is of Ni 1·5 in. dia. by 2 in. in height. The carbon anode is dome shaped, 2·25 in. dia. and 0·063 in. thickness, it may be turned from carbon rod and is mounted into a nonex glass seal with a W rod. Glass and metal shields are provided to shield the anode and cathode respectively from cathode rays. A full description is given of the baking and degassing process.The reliability of these rectifiers is attributed to the heavy seals which allow high currents for thorough baking out and degassing. The use of Ni wire mesh for the cathode adds to the durability since it prevents the oxide coating from flaking off. F. S. B.

1322. The ionosphere. Q. MAJORANA. *N. Cimento*, **16**, *pp.* 459–487, *Nov.*, 1939.—This paper is a general review of experiments concerning the ionosphere and the knowledge about it. It deals with the realization of the existence of a reflecting ionized layer in the upper atmosphere and the theory of the total reflection of radio waves from it. The difference between the real height and the virtual height of the ionosphere is explained. The magneto-ionic theory of the ionosphere, first introduced by Appleton and Burnett is described and the action of a magnetic field on the reflected waves is considered. The question of the stratification and the finer structure of the ionosphere is considered and diagrams given to illustrate it. The problems of the higher atmosphere and the recombination of ions are touched upon. The causes of ionization, temperature of the upper layers and the effect of solar eclipses are all mentioned. The so-called Dellinger effect, with several diagrams to illustrate it, is described. The effects of the moon on transmission, multiple signals and long distance echoes are also mentioned. G. G.

1323. Reception of radio echoes from distant ionospheric irregularities. J. A. PIERCE AND H. R. MIMNO. *Phys. Rev.*, **57**, *pp.* 95–105, *Jan.* 15, 1940.—For many years it has been generally known that strong, sharply defined radio echoes occasionally return to the sending station, or to points within the normal skip-zone, after having traversed a path which greatly exceeds the round trip distance to the F-layer of the ionosphere. Previous investigators tentatively ascribed such effects to reflection from distant mountains or from concentrations of ions in the polar regions. Studies of numerous reflection patterns strongly indicate that the delayed echoes are returned from regions where there is marked curvature of the F-layer. A region of this sort normally occurs at the edge of the sunlit zone and can turn back a ray which may have travelled many thousands of kilometres around the dark side of the earth. Small night-time variations in the curvature of the F-layer are of very common occurrence and are believed to explain several phenomena, including much long-period, long-distance fading. These variations are frequently of cyclic character and may tentatively be attributed to wave motion in the upper atmosphere.

AUTHORS.

1324. Predictions of normal radio critical frequencies related to solar eclipses in 1940. N. SMITH. *Bureau of Standards, J. of Research*, **24**, *pp*, 225–228, *Feb.*, 1940.—The ordinary-wave critical frequencies of the E-, F_1-, F_2-, and night F-layers are predicted for use in ionospheric eclipse observations during the annular solar eclipse of April 7, 1940, and the total solar eclipse of Oct. 1, 1940. The probable reliability and range of application of the data are discussed. AUTHOR.

See also Abstracts 976, 1243, 1251, 1260 and
603B. Problem of critical frequencies. R. Beckmann, W. Menzel and F. Vilbig.

PHOTO-ELECTRICITY.

1325. Electric and photo-electric properties of very thin layers of potassium on glass. G. MACIUC. *Soc. Roumaine de Physique, Bull.*, **40**, 73, *pp.* 3–11, 1939.—The author studies the relation between the electric resistance, the photoelectric emission and the thickness of very thin layers of K deposited on a surface of Duran glass using the 5 779, 5 461, 4 358 and 4 047 Å Hg arc lines. The logarithm of the photo-electric current increases proportionally to the number of the K atoms deposited by evapora-

tion, while the logarithm of the electric resistance diminishes proportionally to this number. These results show the identity of photo-electrons and conduction electrons in very thin layers of K. AUTHOR.

***1326. Photo-electric effect and its application in photocells.** H. VERLEGER. *Zeits, f. Instrumentenk,* **59,** *pp.* 396–415, *Oct.,* 1939.—A general account is given of the principles, modern construction, behaviour (i.e. sensitivity, colour and intensity response, wavelength limits, inertia, fatigue, frequency response, etc.) and a few applications of the most used photo-electric devices, namely the resistance or Se type cell, the barrier-layer photo-elements (metal-semiconductor-metal type), and the vacuum and gas-filled photo-cells. Whilst these are all photo-electric devices they are basically different in action. In the resistance cell a large magnification of the primary photo-current is obtained by the large variation in the resistance of the semiconductor, while with the photo-elements the whole of the purely electronic photo-current is delivered without application of a potential. For small light intensities photo-electric cells must be used with amplification and typical circuits are given for different purposes. The multiplication of photo-electric currents by secondary electron emission and the types of " electron multiplier "designed for this are described. A brief account is given of " photon counters " of the Geiger counter type.

J. B. W.

THERMIONICS.

1327. Thermionic constants of tungsten as a function of crystallographic direction. M. H. NICHOLS. *Phys. Rev.,* **57,** *pp.* 297–306, *Feb.* 15, 1940.—A method is described for recrystallizing W wire into long single crystals occupying the whole cross-section of the wire and so oriented that one of the face diagonals is parallel to the axis of the wire. The temperature dependence of the emission associated with the different crystal directions has been investigated for one such specimen and fitted to the empirical equation $i_0 = A^* T^2 \exp(e\phi_0/kT)$. The values of ϕ_0 range from 4·35 V for the (111) crystal direction to 4·65 V for the (110) crystal direction. The values of A^* range from 125 for the (112) and (001) directions to 15 for the (110) direction. A possible explanation for the low values of A^* is suggested. These results show that the values of ϕ_0 and A^* obtained from the usual measurements on polycrystalline wire are characteristic of a weighted average of the properties of the various crystal surfaces occurring and have, therefore, only empirical value, indicating that all attempts to relate observed to theoretical values of emission constants have so far no great significance. AUTHOR.

See also Abstract 1290.

THERMO-ELECTRICITY.

1328. Heating of thin Mo films in h.f. electric fields. D. A. WRIGHT. *Phys. Soc., Proc.,* **52,** *pp.* 253–265, *March,* 1940.—Mo films, formed by evaporation of Mo on to a glass substrate, are investigated by measurement of the heating which occurs on the application of a h.f. electric field. The effects of varying glass temperature during deposition, and of contaminating the glass with O_2, H_2 and with layers of metallic oxides or fluorides, are observed. The stability of the films is examined and related to the processes of agglomeration and recrystallization. The effect of bombarding the films with electrons is investigated. AUTHOR.

See also Abstract 1218.